



Exploring the World of Science

Test Packet Division B 2017

Division B (Gr. 6-9)

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National Tournament: Division B

School	Anatomy & Physiology	Bio-Process Lab	Crave the Wave	Crime Busters	Disease Detectives	Dynamic Planet	Experimental Design	Food Science	Fossils	Green Generation	Invasive Species	Meteorology	Reach for the Stars	Road Scholar	Wind Power	Write It, Dot	Air Trajectory	Bottle Rocket	Elastic Launch Glider	Bridge Building	Mission Possible	Picture This	Scrambler	Hovercraft Trial	Potions & Poisons Trial	Geocaching Trial	Total	Place	
B09 Daniel Wright Junior H.S. (IL)	17	9	6	4	3	15	12	11	3	15	12	11	3	8	5	3	8	5	3	8	5	1	5	6	7	6	14	182	1
B02 Winston Churchill M.S. (CA)	3	19	3	8	4	6	9	12	11	28	2	7	5	8	5	3	8	5	3	8	5	1	5	6	7	6	10	208	2
B05 Meads Mill M.S. (MI)	4	8	9	13	12	22	10	5	20	19	6	4	13	9	8	11	6	7	1	14	4	13	3	16	28	4	221	3	
B19 Beckendorff Junior High (TX)	15	7	17	9	30	7	1	6	5	2	4	22	23	2	2	4	4	15	11	12	8	2	16	2	1	1	224	4	
B13 Solon M.S. (OH)	2	1	13	2	34	12	2	4	1	23	1	8	20	7	3	37	12	1	6	10	12	15	2	—	2	12	228	5	
B14 Magsig M.S. (OH)	30	5	11	6	7	3	23	7	2	6	26	13	4	12	7	5	17	10	5	21	12	35	10	19	11	272	6		
B06 Lakeshore M.S. (MI)	32	20	14	5	27	5	21	19	6	34	10	17	6	10	10	2	11	7	2	5	19	10	31	7	35	293	7		
B10 Marie Murphy (IL)	11	10	26	7	5	27	4	1	9	7	15	12	16	1	28	9	19	4	2	6	9	21	60	—	61	19	309	8	
B01 Muscatel M.S. (CA)	18	14	21	3	16	10	20	16	32	16	9	24	12	24	11	20	26	3	17	4	10	6	19	34	23	22	351	9	
B07 Paul J. Gelinas Junior H.S. (NY)	13	4	5	16	2	37	8	2	3	14	18	21	3	16	30	22	47	13	9	11	36	37	5	5	27	38	372	10	
B30 Longfellow M.S. (VA)	22	6	1	29	14	17	30	29	7	9	16	15	11	15	17	24	15	14	12	15	15	14	26	9	22	17	373	11	
B11 Springhouse M.S. (PA)	8	18	27	24	31	24	12	9	19	1	28	9	19	26	15	23	14	26	5	18	11	1	36	6	31	8	404	12	
B03 Piedmont IB M.S. (NC)	12	16	2	1	32	14	6	17	10	8	5	15	29	22	25	38	51	8	8	26	18	38	24	29	8	418	13		
B17 Ladue M.S. (MO)	7	2	22	19	21	26	5	20	13	35	7	10	38	13	34	14	9	8	25	39	13	7	44	11	3	30	431	14	
B33 Community M.S. (NJ)	9	24	25	38	18	46	34	26	16	11	33	2	9	22	4	38	21	12	3	3	32	4	17	17	8	6	447	15	
B08 Eagle Hill (NY)	6	28	20	33	19	1	3	15	18	8	29	1	18	6	14	19	41	32	18	48	29	24	37	—	61	—	467	16	
B12 Bala Cywyd M.S. (PA)	5	15	4	25	1	20	17	10	4	15	3	11	21	11	23	42	48	24	35	28	35	51	22	33	42	18	470	17	
B31 Hamilton M.S. (WI)	16	36	15	45	22	30	26	27	30	17	12	14	10	4	13	27	3	9	21	29	52	38	1	—	25	2	497	18	
B15 Dodgen M.S. (GA)	25	12	29	12	37	9	29	23	14	5	20	43	2	17	19	30	36	41	15	9	48	20	11	4	10	16	506	19	
B32 Auburn Junior H.S. (AL)	10	39	19	15	45	12	18	11	25	22	19	33	19	25	35	23	10	16	19	6	41	15	—	20	26	508	20		
B43 Chippewa M.S. (MN)	19	3	8	17	6	2	40	51	22	50	22	25	1	34	33	43	16	48	38	22	23	30	21	15	5	15	574	21	
B04 Fred J. Carnage M.S. (NC)	14	29	30	34	28	11	24	14	29	29	5	46	7	21	37	16	22	37	40	35	17	36	32	—	—	593	22		
B27 Preston M.S. (CO)	21	13	37	20	24	8	25	52	40	4	13	19	27	14	12	13	31	42	53	33	51	3	42	26	40	7	597	23	
B25 Thomas Jefferson M.S. (IN)	36	23	32	18	11	23	22	21	50	13	38	37	25	28	18	29	7	39	14	34	7	25	58	—	26	10	608	24	
B16 Fulton Science Academy (GA)	33	34	7	36	20	16	11	41	12	33	17	48	26	3	16	1	40	36	55	40	20	16	49	21	30	32	610	25	
B38 A. W. Coolidge M.S. (MA)	42	32	10	30	13	14	25	10	38	30	16	24	36	31	62	39	44	19	7	33	11	23	1	33	9	614	26		
B18 Pembroke Hill M.S. (MO)	38	37	42	14	26	33	50	16	31	27	44	23	29	32	24	8	24	16	13	30	28	28	14	—	—	629	27		
B20 Austin Area Homeschoolers (TX)	24	21	28	26	8	56	43	34	34	21	21	6	22	49	41	17	25	19	32	60	37	22	28	—	43	42	674	28	
B44 Highlands Intermediate School (HI)	28	26	39	28	23	18	37	13	45	47	23	26	34	27	9	26	30	53	42	17	47	46	24	3	21	20	708	29	
B26 Bearden M.S. (TN)	1	11	33	32	17	29	39	38	28	20	41	20	14	47	36	10	27	59	39	53	43	23	45	14	36	21	711	30	
B28 California Trail M.S. (KS)	26	46	24	21	35	21	13	22	31	31	50	36	20	35	58	13	43	29	36	32	33	33	—	—	711	31			
B55 Ames M.S. (IA)	29	30	35	43	13	32	27	32	46	3	37	39	43	39	47	12	34	49	20	20	45	49	8	—	44	29	732	32	
B52 Lyme - Old Lyme M.S. (CT)	37	17	23	23	9	35	45	24	37	43	14	32	39	31	43	41	29	46	38	24	22	55	41	35	34	740	33		
B37 HB duPont M.S. (DE)	43	52	16	22	10	50	31	31	36	18	55	29	33	35	21	44	33	38	56	21	16	54	9	19	9	24	753	34	
B40 Russell Independent M.S. (KY)	34	50	34	47	57	36	28	45	53	57	34	38	30	25	32	21	45	6	29	27	3	8	27	12	35	25	766	35	
B21 Archimedean Middle Conservatory (FL)	23	43	18	10	40	34	36	38	21	55	52	47	17	43	29	36	2	31	49	37	56	10	46	22	41	37	770	36	
B51 Stoller M.S. (OR)	35	40	12	42	33	19	44	8	23	25	51	18	50	52	38	34	28	20	41	32	27	57	53	—	—	782	37		
B23 Northshore Junior High (WA)	57	22	48	41	19	15	16	36	38	24	36	27	18	26	50	56	27	28	42	38	40	30	13	4	3	912	38		
B42 Fairfield Junior H.S. (UT)	31	38	58	35	29	28	56	44	55	26	45	47	49	42	46	40	7	35	22	48	45	14	52	4	—	—	851	39	
B36 North Bethesda M.S. (MD)	46	53	36	27	36	44	46	37	52	46	35	28	40	30	20	18	44	30	36	36	30	34	52	32	38	27	856	40	
B24 Frontier M.S. (VA)	54	33	43	44	56	41	32	30	47	53	49	31	41	45	50	39	20	35	33	38	19	32	18	—	—	883	41		
B35 Albuquerque Area Home Schoolers (NM)	27	49	40	58	39	60	38	42	35	56	42	51	45	33	53	46	11	23	46	44	2	26	39	—	13	905	42		
B47 Clinton M.S. (SC)	47	27	45	57	38	38	49	58	27	40	39	35	47	37	27	33	10	55	37	53	31	43	34	—	—	907	43		
B56 Hyde Park Middle School Academy of Science and Mathematics (NV)	20	25	38	39	47	31	53	28	34	31	52	33	51	40	52	31	51	54	57	41	49	27	25	28	13	5	910	44	
B58 Yankton M.S. (SD)	49	51	44	31	48	48	54	46	38	49	50	55	35	44	39	40	49	21	27	33	18	7	18	34	33	918	45		
B34 Mission M.S. (NE)	40	31	31	11	46	40	48	39	26	54	40	45	32	23	48	53	53	58	45	52	42	44	25	29	37	44	926	46	
B45 St. Joseph's Catholic (ID)	53	54	55	55	44	39	19	49	8	37	24	22	60	51	51	32	52	52	31	51	46	17	43	23	18	23	965	47	
B29 Wachter M.S. (ND)	39	48	49	37	45	63	52	47	41	32	46	44	52	42	59	28	47	43	25	54	35	29	—	—	985	48			
B22 Galaxy M.S. (FL)	51	42	53	40	52	45	51	50	53	40	59	40	37	48	44	52	32	34	44	56	25	47	20	—	16	39	1006	49	
B41 Paragon Science Academy (AZ)	59	55	51	49	61	52	35	57	57	42	48	52	54	50	1	47	37	29	24	31	39	31	48	—	—	1009	50		
B46 Casady School (OK)	44	44	41	46	54	51	47	40	42	36	45	54	44	41	42														

Air Trajectory Scoring Sheet

2015-2016 Season Version 1.0

Team #	Team Name	Close Target 1		Close Target 2				Far Target 1		Far Target 2				Graph Score					# of Penalties	Tier (Y/N)	TB2: Mass (g)	CT1	CT2	FT1	FT2	Final Score	Rank
		Distance (mm)	Failed Launch (Y/N)	Distance (mm)	Failed Launch (Y/N)	Bucket Shot (Y/N)	Hits Bucket (Y/N)	Distance (mm)	Failed Launch (Y/N)	Bucket Shot (Y/N)	Hits Bucket (Y/N)	Bottom Contact (Y/N)	# Plots (max 4)	Data Table (max 20)	Graph (max 20)	Match (max 20)	Labels (max 40)										
1	Muscatel Middle School (CA)	65				y	n	n	350		1380			4	20	20	20	40		400	1935	0	3650	2620	5985	26	
2	Winston Churchill Middle School (CA)	195				y	n	y	736		240			4	20	20	20	40		4700	1805	300	3264	3760	6265	8	
3	Piedmont IB Middle School (NC)	530				y	n	n	180					4	20	20	20	40		4200	1470	0	3820	0	5690	38	
4	Fred J. Carnage Middle School (NC)	92				y	n	n	322					4	20	20	20	25		4100	1908	0	3678	3776	6024	22	
5	Meads Mill Middle School (MI)	50				y	y	n	390					4	20	20	20	40		2200	1950	100	3610	3950	6400	6	
6	Lakeshore Middle School (MI)	66				y	n	y	295					4	20	20	20	35		2800	1934	300	3705	300	6619	1	
7	Paul J. Gelinas Junior High School (NY)	249				375			847					4	20	20	20	40		4900	1751	1625	3153	3129	5304	47	
8	Eagle Hill (NY)	530				808			280					4	20	20	20	35		5000	1470	1192	3720	3475	5570	41	
9	Daniel Wright Junior High School (IL)	158				y	y	n	355					4	20	20	20	40		4200	1842	100	3645	100	6087	17	
10	Marie Murphy (IL)	97				y	n	n	445		230			4	20	20	20	40		3100	1903	0	3555	3770	6073	19	
11	Springhouse Middle School (PA)	287				70			564		200			4	20	20	20	40		2400	1713	1930	3436	3800	6130	14	
12	Bala Cynwyd Middle School (PA)	1223				530			824		655			4	20	20	20	40		3200	777	1470	3176	3345	5215	48	
13	Solon middle School (OH)	76				y	y	n	268		359			4	20	20	20	40		1300	1924	100	3732	3641	6156	12	
14	Marsig Middle School (OH)	123				y	y	n	40					4	20	20	20	38		3600	1877	100	3960	100	6429	5	
15	Dodgen Middle School (GA)	515				278			337		604			4	20	20	20	40		4800	1485	1722	3663	3396	5785	36	
16	Fulton Science Academy (GA)	150				y	n	n	630		870			4	20	20	20	40		3500	1850	0	3370	3130	5620	40	
17	Ladue Middle School (MO)	236				155			197		0			4	20	20	20	40		700	1764	1845	3803	4000	6245	9	
18	Pembroke Hill Middle School (MO)	195				y	n	n	202					4	20	20	20	40		4800	1805	0	3798	0	6003	24	
19	Beckendorff Junior High (TX)	266				68			144					4	20	20	20	40		2000	1734	1932	3856	300	6488	4	
20	Austin Area Homeschoolers (TX)	303				207			604		204			4	20	20	20	40		2600	1697	1793	3396	3796	5989	25	
21	Archimedean Middle Conservatory (FL)	90				y	n	y	304					4	20	20	20	40		3200	1910	300	3696	300	6606	2	
22	Galaxy Middle School (FL)	205				224			634		334			4	20	20	20	40		5000	1795	1776	3366	3666	5861	32	
23	Northshore Junior High (WA)	173				y	n	y	1745		1882			1	20	20	20	25		1600	1827	300	2255	2118	4467	56	
24	Frontier Middle School (WA)	288				134			812		98			4	20	20	20	40	1	4400	1712	1866	3188	3902	6068	20	
25	Thomas Jefferson M.S. (IN)	378				83			210					4	20	20	18	40		4000	1622	1917	3790	300	6399	7	
26	Bearden Middle School (TN)	384				y	n	n	105					4	20	20	20	40		500	1616	0	3895	0	5911	27	
27	Preston Middle School (CO)	105				y	n	n	1050		394			4	20	20	20	30		2400	1895	0	2950	3606	5861	31	
28	California Trail Middle School (KS)	1150				37			1053		190			4	20	20	20	35		5000	850	1963	2947	3810	6153	13	
29	Wachter Middle School (ND)	313				y	n	n	1924		1968			4	20	20	10	35		5000	1687	0	2076	2032	4103	57	
30	Longfellow Middle School (VA)	210				y	n	n	149					4	20	20	20	35		3500	1790	0	3851	100	6121	15	
31	Hamilton Middle School (WI)	90				y	n	y	172					4	20	20	18	40		3500	1910	300	3828	100	6530	3	
32	Auburn Junior High School (AL)	320				y	n	n	68					4	20	20	20	40		2800	1680	0	3932	0	6012	23	
33	Community Middle School (NJ)	519				213			390		144			4	20	20	20	40		4900	1481	1787	3610	3836	6043	21	
34	Mission Middle School (NC)	395				1309			1948		1370			4	15	20	20	40		4700	1605	691	2052	2630	4615	53	
35	Albuquerque Area Home Schoolers (NM)	470				108			119					4	20	20	20	40		1000	1530	1892	3881	0	6173	11	
36	North Bethesda Middle School (MD)	97				y	y	n	964		1083			4	20	20	15	40		1700	1903	100	3036	2917	5419	44	
37	HB duPont Middle School (MD)	449				y	n	n	895		102			4	20	20	20	40		4000	1551	0	3105	3898	5849	33	
38	A.W. Coolidge Middle School (MA)	255				y	n	n	379		743			4	20	20	20	40	1	3600	1745	0	3621	3257	5666	39	
39	Corvallis Middle School (MT)	835				930			4000		4000			4	20	20	20	40		3400	1165	1070	0	0	1565	58	
40	Russell Independent Middle School (KY)	226				y	y	n	868		1194			4	20	20	20	40		5000	1774	100	3132	2806	5406	45	
41	Paragon Science Academy (AZ)	990				322			257		183			4	20	20	10	40	1	2200	1010	1678	3743	3817	5755	37	
42	Fairfield Junior High (UT)	435				y	N	N	132					4	20	20	20	30		3900	1565	0	3868	0	5793	35	
43	Chippewa Middle School (MN)	129				y	y	n	366					4	20	20	20	40		1400	1871	100	3634	100	6105	16	
44	Highlands Intermediate School (HI)	84				y	n	n	453		655			4	20	20	20	40		3100	1916	0	3547	3345	5863	30	
45	St. Joseph's Catholic (ID)	940				539			1489		957			4	20	20	20	25		1800	1060	1461	2511	3043	4844	52	
46	Cassady School (OK)	460				y	n	n	864		415			4	20	20	20	40		4900	1540	0	3136	3585	5525	42	
47	Clinton Middle School (SC)	70				y	y	n	210		800			4	20	20	20	35		3200	1930	100	3790	3200	6200	10	
48	Barrington Middle School (RI)	39				y	n	n	551		774			2	20	20	0	35	1	3300	1961	0	3449	3226	5460	43	
49	Germantown Middle School (MS)	1041				1350			4000		4000			1	20	20	20	35	3	4000	959	650	0	0	754	59	
50	Teeland Middle School (AK)	57				0			817		314			4	20	20	20	40		2600	1943	2000	3183	3686	6086	18	
51	Stoller Middle School (OR)	79				0			400		626			4	20	20	18	40	1	3900	1921	2000	3600	3374	5892	28	
52	Lyme-Old Lyme Middle School (CT)	250				y	n	n	280					4	20	20	20	40		3600	1750	0	3720	0	5870	29	
53	LISA Academy (AR)	874				534			1966		460			1	20	20	0	10		2100	1126	1466	2034	3540	5056	50	
54	St. John Berchmans (LA)	730				280			1480		1494			4	20	20	20	40	1	3700	1270	1720	2520	2506	4540	55	
55	Ames Middle School (IA)	344				487			308					4	20	20	20	40		3600	1656	1513	3692	100	5848	34	
56	K Middle Academy of Science and Mathematics	1280				325			1070		1822			4	20	20	0	35</td									

National Science Olympiad 2016, Anatomy and Physiology Division B

Station A (upper extremity model)

1. Name the muscle tagged with #1 on the model: _____.
2. Name the muscle tagged with #2 on the model: _____.
3. The antagonist of the muscle tagged #3 on the model is the _____.
4. The major muscle used to abduct the arm when performing the chicken dance (shown below) is the _____.



5. Which one of the following is **FALSE** about skeletal muscles?
 - a. Tendons attach muscles to bone.
 - b. The perimysium is the sheath of connective tissue that covers the entire muscle.
 - c. The plasma membrane of a muscle cell is called the sarcolemma.
 - d. The sarcoplasmic reticulum releases calcium to initiate muscle cell contraction.
6. Which one of the following muscles does **NOT** flex the knee?
 - a. Biceps femoris
 - b. Rectus femoris
 - c. Semimembranosus
 - d. Semitendinosus

National Science Olympiad 2016, Anatomy and Physiology Division B

Station B (lower extremity model)

7. Name the muscle tagged with #7 on the model: _____.
8. Name the muscle tagged with #8 on the model: _____.
9. The function of the muscle tagged #9 is to: _____.
10. Bart Simpson fell while skateboarding and injured the front of his shin. If the wound is deep enough, what muscle is mostly likely to be affected? _____



11. Which one of the following is **NOT** a function of muscle tissues?
 - a. Stabilization of joints
 - b. Storage of lipids
 - c. Generation of heat
 - d. Moving substances within the body
12. A class of pesticides called organophosphates prevents the degradation (break down) of acetylcholine in the synapse of the neuromuscular junction. What symptoms, then, would you expect to find in someone who had been poisoned by them? Choose the best answer.
 - a. Muscle contraction would be weaker than normal.
 - b. Muscles would all be relaxed and unable to contract.
 - c. Muscles would all be contracted and unable to relax.
 - d. Muscle contraction would be extra strong.

National Science Olympiad 2016, Anatomy and Physiology Division B

Station C (Microscope & slides)

13. The muscle tissue shown on the slide could be from which one of the following organs?

- a. The heart
- b. The small intestine
- c. The rectus abdominis muscle
- d. A blood vessel

14. Which one of the following is **FALSE** about smooth muscle?

- a. The cells are spindle-shaped
- b. The cells have no striations
- c. The cells have multiple nuclei
- d. Control is involuntary

15. After contraction or extension, muscle tissue will return to its original shape. This characteristic of muscle tissue is called: _____.

16. When a muscle contracts, what happens to its overall shape?

- a. It lengthens and thins out
- b. It lengthens and thickens
- c. It shortens and thickens
- d. It shortens and thins out

17. What are myofibrils?

- a. Bundles of thick and thin filaments inside a muscle fiber
- b. Bundles of muscle fibers inside a fascicle
- c. Bundles of muscle fibers inside a muscle
- d. Bundles of fascicles inside a muscle

18. Which one of the following is true about creatine?

- a. It is a waste product of protein metabolism that is excreted in the urine
- b. It can be phosphorylated to become a form of energy storage
- c. Taking creatine supplements can cause permanent improvement in muscle strength
- d. It is an essential amino acid needed for muscle contraction

National Science Olympiad 2016, Anatomy and Physiology Division B

Station D (Torso model)

19. Name the muscle tagged with #19 on the model: _____.

20. Name the muscle tagged with #20 on the model: _____.

21. Name the muscle tagged with #21 on the model: _____.

22. Which of the following is true about the sliding filament theory of muscle contraction?

- a. Myosin slides over actin to lengthen the sarcomere
- b. The A band of the sarcomere shortens during muscle contraction
- c. Energy in the form of ATP is required for relaxation of the sarcomere
- d. The actin heads bind to myosin and pull it toward the center of the sarcomere

23. Julie performs pull-ups to the point where her muscles are completely fatigued and she can no longer do any more. Which one of the following statements about her muscles at this point is **FALSE**?

- a. Lactic acid levels are high
- b. ATP levels are high
- c. Oxygen levels are low
- d. Carbon dioxide levels are high



24. The I Band of a sarcomere...

- a. Appears dark due to the presence of actin filaments
- b. Lengthens during a muscle contraction
- c. Stays the same size during a muscle contraction
- d. Appears light due to the absence of myosin filaments

National Science Olympiad 2016, Anatomy and Physiology Division B

Station E (#5) (Skeleton)

25. Name the bone tagged as #25: _____.

26. Name the bone tagged as #26: _____.

27. What is the **shape** of the bone tagged #27? _____.

28. What is the **type** of joint tagged as #28?

- a. Ball and socket
- b. Hinge
- c. Saddle
- d. Pivot
- e. Condyloid

29. Tamara accidentally bopped Danny on the nose during a dance rehearsal. The treating physician told Danny that the injury only affected the cartilage of his nose, not the bone. Which one of the following would be **correct** advice from the physician, based on what you know about cartilage?

- a. This injury will heal quickly, as cartilage has a lot of blood vessels.
- b. This injury will bleed a lot, as cartilage has a lot of blood vessels.
- c. This injury shouldn't be too severe, as cartilage is resilient.
- d. Once a callus forms, the injury will not be so painful.



30. Spongy bone is **NOT** typically found in which location?

- a. The head of the femur
- b. Inside the ribs
- c. The shaft of the radius
- d. Inside the tarsals

National Science Olympiad 2016, Anatomy and Physiology Division B

Station F (#6) (Loose bones)

31. Name the bone tagged #31: _____.

32. Name the bone tagged #32 (be specific): _____.

33. Name the part of the long bone indicated by #33:

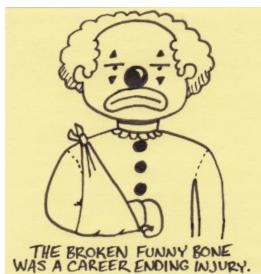
- a. Epiphysis
- b. Metaphysis
- c. Diaphysis
- d. Hypophysis

34. Which one of the following would you **NOT** expect to see in a cross-section of the bone at the location of the #34 tag?

- a. Yellow marrow
- b. Medullary cavity
- c. Compact bone
- d. Spongy bone

35. Bubbles the clown broke his funny bone. Choose the appropriate order for bone healing and repair, from first to last.

- a. Hematoma, bony remodeling, fibrocartilage callus, bony callus
- b. Fibrocartilage callus, hematoma, bone remodeling, bony callus
- c. Hematoma, fibrocartilage callus, bone remodeling, bony callus
- d. Hematoma, fibrocartilage callus, bony callus, bone remodeling



36. Alex develops gradually worsening lower back pain in his early 20's. He also notes a loss of flexibility of his spine. There are no symptoms of nerve or spinal cord impingement, and no other joints are involved. What is the most likely diagnosis?

- a. Osteosarcoma
- b. Ankylosing spondylitis
- c. Spinal stenosis
- d. Juvenile rheumatoid arthritis

National Science Olympiad 2016, Anatomy and Physiology Division B

Station G (#7) Skeleton

37. Name the bone tagged #37: _____.

38. Name the bone tagged #38: _____.

39. Choose the appropriate name for the bony feature tagged #39:

- a. Tuberclle
- b. Tuberosity
- c. Trochanter
- d. Epicondyle

40. Which one of the following is **NOT** a function of the skeletal system?

- a. Protection of internal organs
- b. Support of the body
- c. Lipid production
- d. Blood cell production
- e. Mineral storage

41. In the condition called achondroplasia, there is a defect of the epiphyseal plate. Why does this cause short stature? Choose the best answer.

- a. Intramembranous ossification cannot occur normally.
- b. Endochondral ossification cannot occur normally.
- c. Bone remodeling by osteoclasts cannot occur normally.
- d. Primary ossification centers cannot form normally.



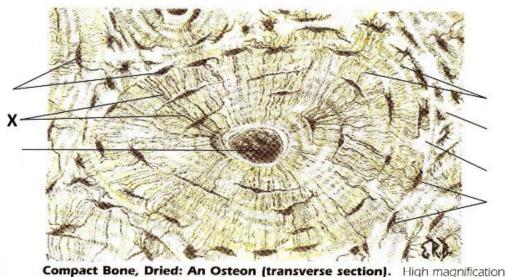
42. Name TWO types of arthritis: _____ & _____.

National Science Olympiad 2016, Anatomy and Physiology Division B

Station H (#8) Microscope and slide, Enlarged diagrams

43. Name the structure indicated by the pointer on the slide: _____

44. On the diagram, X is indicating tiny linear structures called: _____.



Compact Bone, Dried: An Osteon (transverse section). High magnification.

45. What structure passes through the foramen magnum of the skull?

- a. Carotid artery
- b. Spinal cord
- c. Jugular vein
- d. Facial nerve

46. When you bang your shin, it can really hurt. This is because there are a lot of nerve fibers located in the _____ of the bone.

47. The small, rounded bones indicated by the arrows on this X-Ray of a foot are called _____.



48. Bone is a specialized connective tissue composed of specialized cells in a matrix. For bone, the matrix has two main components, which give it hardness and resiliency. They are:
_____ and _____.

National Science Olympiad 2016, Anatomy and Physiology Division B

Station I (#9) (Skin Model)

49. Identify the structure tagged #49: _____.

50. Identify the structure tagged #50: _____.

51. The **layer** of skin tagged #51 is the _____.

52. Which one of the following is **NOT** a function of the integumentary system?

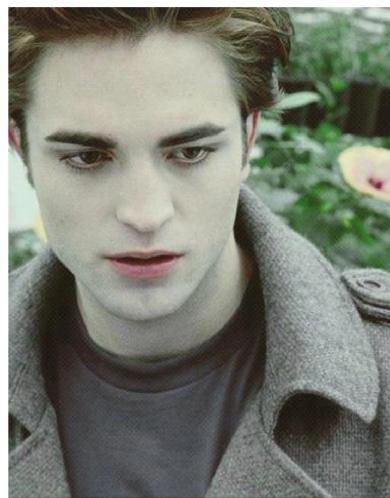
- a. Regulation of body temperature
- b. Synthesis of needed chemicals
- c. Provision of sensory input
- d. Protection from water loss
- e. Production of antibodies

53. Which one of the following skin conditions is contagious?

- a. Psoriasis
- b. Contact dermatitis
- c. Impetigo
- d. Melanoma

54. A patient in the Emergency Room is found to be unusually pale. Which one of the following would not be a potential cause of the patient's appearance?

- a. Blood loss
- b. Albinism
- c. Anemia
- d. High blood pressure
- e. Hypothermia



National Science Olympiad 2016, Anatomy and Physiology Division B

Station J (#10) Microscopes (2) and Slides

55. Identify the structure at the pointer _____.

56. What layer of the skin is indicated by the pointer in #55? _____.

57. What is the function of the structure indicated by the pointer?

- a. To produce sebum
- b. To produce sweat
- c. To perceive pressure and vibration
- d. To perceive light touch

58. Keratinocytes are most mitotically active in the:

- a. Stratum corneum
- b. Stratum spinosum
- c. Stratum basale
- d. Stratum lucidum

59. A disorder of what type of cells could cause difficulty in fighting infection?

- a. Langerhans cells
- b. Merkel cells
- c. Melanocytes
- d. Keratinocytes

60. You're babysitting two little kids and think they're taking a nap, but when you enter the room to check, you find that they've drawn all over themselves with permanent markers. Based on what you know about skin, what is most likely true?



- a. The ink will have only permeated the stratum spinosum, and no other layers.
- b. If the ink has permeated down to the stratum basale, it will take about four weeks for the marks to disappear.
- c. The ink cannot permeate past the stratum granulosum, due to the tight cellular connections there.
- d. The acid mantle of the skin will prevent the ink from penetrating into the hypodermis.

National Science Olympiad 2016, Anatomy and Physiology Division B

Station K (#11) Skin Model

61. Identify the structure tagged #61: _____.

62. Identify the structure tagged #62: _____.

63. Which one of the following is **FALSE** about the structure tagged #63?

- a. It helps to keep the epidermis and dermis firmly attached.
- b. It contains blood vessels.
- c. It contains nerve endings.
- d. It causes the phenomenon of fingerprints.
- e. It contains sweat glands.

64. Which one of the following is **FALSE** about thin versus thick skin?

- a. Thin skin has more hair than thick skin.
- b. Thin skin has more sweat glands than thick skin.
- c. Thin skin has fewer sensory receptors than thick skin.
- d. Thin skin has less keratin than thick skin.

65. Some specialized skin cleansers have a slightly acidic to neutral pH, rather than the alkaline pH typically found in soaps. The reason they are formulated this way is to:

- a. Avoid disruption of the acid mantle, thus preserving skin's defense against bacteria and decreasing acne.
- b. Strip away some of the dead skin cells present in the stratum basale, thus giving skin a more youthful appearance.
- c. Avoid irritation of the stratum spinosum, thus decreasing the risk of redness, peeling, and rashes.
- d. Penetrate more deeply into the skin, thus nourishing the collagen in the dermis, to help prevent wrinkles and premature aging.

66. During the industrial revolution, adults and children alike worked long hours in factories and seldom saw daylight. What condition, therefore, became very common during that time period?

- a. Psoriasis
- b. Rickets
- c. Osteogenesis imperfecta
- d. Eczema



National Science Olympiad 2016, Anatomy and Physiology Division B

Station L (#12)

67. Warts are caused by: _____.

68. Permethrin cream, which is an anti-parasitic, is the treatment for what skin condition?
_____.

69. The most common form of skin cancer is:

- a. Melanoma
- b. Squamous Cell Carcinoma
- c. Basal Cell Carcinoma
- d. Merkel Cell Carcinoma

70. Which of the following is **FALSE** regarding glands in the skin?

- a. Eccrine sweat glands begin to function at puberty.
- b. Apocrine sweat glands are stimulated by emotional stress.
- c. Sebaceous glands secrete an oily lubricating substance onto hair and skin.
- d. Ceruminous glands are special glands in the external ear.

71. Sam forgets to wear sunscreen when he goes to the beach. He gets a sunburn, and his skin becomes red and painful. There are no blisters. Several days later, his skin also starts to peel a bit. Which one of the following statements is **true** about Sam's sunburn?

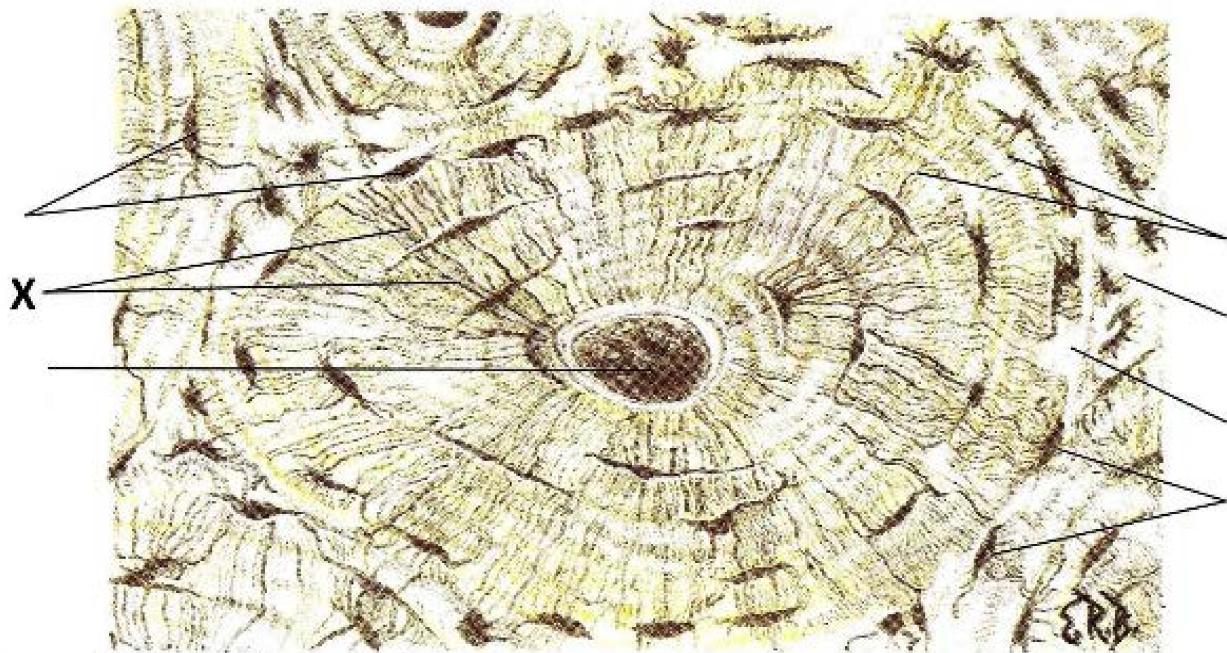
- a. He did not have a sufficient number of melanocytes to protect himself from the sun.
- b. Given that he has peeling, the burn must have extended down into the dermis.
- c. This is a first-degree burn and should heal without scarring.
- d. Given that he did not have blisters, this will not increase his future risk of skin cancer.



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72. When cancer patients are treated with certain kinds of chemotherapy, about 85% of their hair will fall out. This is because the chemo disrupts hair in which phase? _____.

Question #44 Diagram



Compact Bone, Dried: An Osteon (transverse section). High magnification.

Question #47 Image



National Science Olympiad 2016, Anatomy and Physiology, Division B, Answer Sheet

Team/School Name: _____

Individual Names: _____ & _____

Please make sure that all answers are clearly legible. Be sure to write each answer in the appropriate space.

Station A 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____	Station B 7. _____ 8. _____ 9. _____ 10. _____ 11. _____ 12. _____
Station C 13. _____ 14. _____ 15. _____ 16. _____ 17. _____ 18. _____	Station D 19. _____ 20. _____ 21. _____ 22. _____ 23. _____ 24. _____
Station E 25. _____ 26. _____ 27. _____ 28. _____ 29. _____ 30. _____	Station F 31. _____ 32. _____ 33. _____ 34. _____ 35. _____ 36. _____

National Science Olympiad 2016, Anatomy and Physiology, Division B, Answer Sheet

Station G 37. _____ 38. _____ 39. ____ 40. ____ 41. ____ 42. _____ and _____.	Station H 43. _____ 44. _____ 45. ____ 46. _____ 47. _____ 48. _____ and _____
Station I 49. _____ 50. _____ 51. _____ 52. ____ 53. ____ 54. ____	Station J 55. _____ 56. _____ 57. ____ 58. ____ 59. ____ 60. ____
Station K 61. _____ 62. _____ 63. ____ 64. ____ 65. ____ 66. ____	Station L 67. _____ 68. _____ 69. ____ 70. ____ 71. ____ 72. _____

National Science Olympiad 2016, Anatomy and Physiology, Division B, Answer Sheet

Team Name: _____ KEY _____

Individual Names: _____ & _____

Please make sure that all answers are clearly legible. Be sure to write each answer in the appropriate space.

<p>Station A</p> <ol style="list-style-type: none"> 1. __extensor digitorum____ 2. __flexor carpi radialis____ 3. __Triceps brachii (1/2 for just triceps)___ 4. __deltoid_____ 5. __b__ 6. __b__ 	<p>Station B</p> <ol style="list-style-type: none"> 7. __peroneus longus OR fibularis longus____ 8. __tensor fascia lata____ 9. __extend the knee (1/2 for straighten knee or extension only) 10. __tibialis anterior (ok if reversed)___ 11. __b__ 12. __c__TIEBREAKER
<p>Station C</p> <ol style="list-style-type: none"> 13. __c__ 14. __c__ 15. __elasticity OR elastic recoil (1/2 for recoil only) 16. __c__ 17. __a__ 18. __b__TIEBREAKER 	<p>Station D</p> <ol style="list-style-type: none"> 19. __zygomaticus major (1/2 for no major)___ 20. __serratus anterior___ 21. __external intercostal___ 22. __c__ 23. __b__ 24. __d__
<p>Station E</p> <ol style="list-style-type: none"> 25. __ulna____ 26. __fibula____ 27. __long bone____ 28. __b__ 29. __c__ 30. __c__ 	<p>Station F</p> <ol style="list-style-type: none"> 31. __temporal bone____ 32. __C2 or Axis (1/2 for cervical vertebra)___ 33. __a__ 34. __d__ 35. __d__ 36. __b__TIEBREAKER

National Science Olympiad 2016, Anatomy and Physiology, Division B, Answer Sheet

<p>Station G</p> <p>37. <u>1st metatarsal (1/2 for just metatarsal)</u></p> <p>38. <u>sacrum</u></p> <p>39. <u>b</u></p> <p>40. <u>c</u></p> <p>41. <u>b</u></p> <p>42. Need two: osteoarthritis, rheumatoid arthritis, juvenile rheumatoid, gout, infectious (e.g. Lyme)</p>	<p>Station H</p> <p>43. <u>Central/Haversian canal</u></p> <p>44. <u>canaliculi</u></p> <p>45. <u>b</u></p> <p>46. <u>periosteum</u></p> <p>47. <u>sesamoid bones</u></p> <p>48. <u>Ca/Ca-phosphate/hydroxyapatite (1/4 for minerals) & collagen (1/4 for proteins)</u></p>
<p>Station I</p> <p>49. <u>arrector pili muscle</u></p> <p>50. <u>nerve ending (Paccinian corpuscle TIEBREAKER)</u></p> <p>51. <u>epidermis</u></p> <p>52. <u>e</u></p> <p>53. <u>c</u></p> <p>54. <u>d</u></p>	<p>Station J</p> <p>55. <u>hair follicle</u></p> <p>56. <u>dermis</u></p> <p>57. <u>b</u></p> <p>58. <u>c</u></p> <p>59. <u>a</u></p> <p>60. <u>b</u></p>
<p>Station K</p> <p>61. <u>sweat duct or pore</u></p> <p>62. <u>sebaceous gland</u></p> <p>63. <u>e</u></p> <p>64. <u>b</u></p> <p>65. <u>a TIEBREAKER</u></p> <p>66. <u>b</u></p>	<p>Station L</p> <p>67. <u>HPV/Human papillomvirus</u></p> <p>68. <u>scabies</u></p> <p>69. <u>c</u></p> <p>70. <u>a</u></p> <p>71. <u>c TIEBREAKER</u></p> <p>72. <u>anagen</u></p>

Station A: Microscopy

Use the **compound microscope**, the **clear mm ruler**, **slide of "ae"**, **Field of View diagram**, and the **photo of Human Cheek Cells** to assist you in answering the questions.

1. List the **total magnification** possible for each of the objectives of the compound microscope (**low to high**).
2. As you move from **low** power to **high** power, what happens to the **size** of the **field of view**, **brightness**, and **depth of focus**? On your answer sheet indicate whether each **increases (I)** or **decreases (D)**.
3. Using the hands of the clock, a protozoan is observed and appears to be moving **toward 5 o'clock**. What direction is the protozoan actually moving?
4. A student prepares a slide with the letters "**ae**" and positions it on the stage in the normal reading position. When viewed, how will the "**ae**" appear? **Draw it on your answer sheet.**
5. The **working distance** is the space between the objective lens and the slide. Which objective will provide the **smallest** working distance for this microscope? (list its power) What would be the **total magnification** of this microscope when using **this** objective?
6. **Field of view** is defined as area that is visible with each objective. What fraction of the **diameter** of a 10X (low power) field of view is the **diameter** of a 40X (high power) field of view? What fraction of the **area** of a 10X (low power) field of view will be visible for a 40X (high power) field of view?
7. Examine the **Field of View Diagram**. Using this diagram showing the millimeter ruler under lower power, Assuming the diameter of this field of view (**10X** objective) is 1.6 mm. What is it in micrometers or **mcm**?
8. Examine the **Photo of the cheek cells**. Assume that it was taken in the same field of view (**10X** objective) as the Field of View Diagram. What is the length of the of the cheek cell indicated by the red line in micrometers or **mcm**?
9. Assuming the field of view diagram for low power (10X) is 1.6 mm, what should be the diameter of the **40X** field of view **in millimeters?** **in micrometers or mcm?**
Note: Remember that it needs to be calculated.
10. If **240** evenly distributed cells are visible in the entire low (**10X**) power field of view, how many cells should be visible in the high (**40X**) power field of view for the same microscope?

Station B: Diagram Analysis

For Questions 11- 12, use the Karyotype Background and **Karyotypes A & B**.

11. Which karyotypes are female? What condition do these individuals have?
12. Which karyotypes are male? What condition do these individuals have?

For Questions 13-15, Use the Pedigree Background and **Pedigrees P-S**.

13. Which pedigree is **autosomal dominant**? Which pedigree is **autosomal recessive**?
14. Which pedigree is **sex-linked recessive**? Which pedigree is **sex-linked dominant**?
15. In **Pedigree Q**, how are Individuals I-2 and III-6 related?

For Questions 16-20, use Key of Genotypes to give the genotype of the Individuals from **Pedigrees P-S**.

For each individual, give the **LETTER** from the **KEY OF GENOTYPES** which represents the genotype of that individual

KEY of GENOTYPES

- A. AA
- B. AA or Aa
- C. Aa
- D. aa
- E. X^A X^A
- F. X^A X^a
- G. X^a X^a
- H. X^A y
- I. X^a y

For each individual, the **letter** is the pedigree, **Roman numeral** is the generation and **number** is the individual on the pedigree. (P II-3)

- | | |
|------------------------|---------------------|
| 16. Individual P I-2 | Individual P II-8 |
| 17. Individual Q I-1 | Individual Q II-2 |
| 18. Individual Q III-2 | Individual R II-2 |
| 19. Individual R II-6 | Individual S I-1 |
| 20. Individual S II-4 | Individual S III-10 |

Station C: Experimental Design

For Questions 21-30, use the Background, Experimental Setup and Data that is provided.

21. What cell process is being tested?
What organelle in plants is responsible for this cell process?
22. What is the pigment found in this organelle and what does it do for this process?
23. What are the raw materials needed for this cell process?
24. Why was the baking soda (sodium bicarbonate) added?
25. What were the **independent variable for each test**? How was it measured?
26. What is the **dependent variable**? How is it measured?
27. What variables should have been controlled in experiment?
28. If a plant carries out his cell process under water, what gas would be visibly bubbling from the plant?
What else is being produced in this process along with the gas?
29. What % of the bubbles produced at 10 cm were produced at 20 cm? (to the nearest %)
What % of the bubbles produced at 10 cm were produced at 30 cm? (to the nearest %)
30. What did the study discover?

Station D: Data Interpretation**For Questions 31-33, use the Food Group Pyramid.**

- 31.** How many servings are recommended for the food group that provides most of the daily energy for your body?
- 32.** How many food groups provide most of the protein in your diet? How many serving are in each of these two groups?
- 33.** Which groups are purchased fresh and come from parts of plants? What is the range of recommended servings that comes from these groups combined?

For Questions 34-40, use the Food Label for Roast Beef Hash**Note: Round off calculations to the nearest whole number.****Fats = 9 cal/g Protein & carbohydrates = 4 cal/g**

- 34.** How many grams per container? How many grams per serving?
- 35.** How many servings per container? How many calories per serving?
- 36.** What % of a single serving is protein?
What % of the calories per serving come from protein?
- 37.** What % of a single serving is Total Carbohydrate?
What % of the daily value is this for a 2000 calorie diet?
- 38.** What % of a single serving is Total Fat?
What % of the daily value is this for a 2000 calorie diet?
- 39.** What is the best vitamin source? What is the best mineral source (other than sodium)?
- 40.** What percent of a prepared serving is neither protein, fat, nor carbohydrate?
What makes up most of this percentage?

Station E: Lab Equipment & Safety

For Questions 41-42, Use the *Safety Symbols A-D*?

41. What is safety symbol A? What is safety symbol B?
42. What is safety symbol C? What is safety symbol D?

For Questions 43-44, use the Observed Activities List.

43. Which of the observed activities would be considered safe and proper for a student's health and safety? **Put the letters of the activities on your answer sheet.**
44. Which of the observed activities would be considered unsafe and should not be done in the laboratory? **Put the letters of the activities on your answer sheet.**
45. During a measurement, you drop the thermometer on the floor and it breaks. Choose the correct procedure(s) for dealing with this situation.
 - A. Notify your teacher.
 - B. Pick up the broken glass with your hands and put in the wastebasket.
 - C. Pick up the broken glass with your hands and put it in the designated container.
 - D. Sweep up the broken glass and put it in the wastebasket.
 - E. Sweep up the broken glass and put it in the designated container.

For Questions 46-50, use the Equipment with Letters.

46. Give the **letter** and **name** of the piece of laboratory equipment **which should be used to measure 30 mL of a liquid.**
47. Give the **letter** and **name** of the piece(s) of laboratory equipment **which should be used to take ones blood pressure.**
48. Give the **letters** of those pieces of laboratory equipment **that could be used to determine the temperature of the water in a stream.**
49. Give the **letters** of those pieces of laboratory equipment **that would be used to transfer bacteria and prepare a new culture.**
50. Give the **letters** of those pieces of laboratory equipment **that would be used to prepare a wet mount and observe the cellular structure of pond algae.**

Station F: Measurement

For Questions 51-56, use the metric ruler, graduated cylinder, lab thermometer and material to be measured.

- 51.** What are the **numbered and unnumbered metric increments** for the **metric ruler?** (in millimeters)
- 52.** Determine the **length of critter A** (from A to B) to the tenth of a centimeter? to the whole millimeter?
- 53.** What are the **numbered and unnumbered increments** of the **actual graduated cylinder?**
- 54.** What are the **numbered and unnumbered increments** of the **photo of a graduated cylinder?**
- 55.** What is the **reading** on the **photo** of the graduated cylinder?
- 56.** What is its temperature reading on the **diagram** of a thermometer?

For Questions 57 & 58, use the Electronic Balance and Object A.

- 57.** What is the **most specific metric unit** on this balance?
- 58.** What is the mass **in grams** of **Object A?**

For Questions 58-60, use the triple beam balance, set of weights, and Object X.

- 59.** What is the actual combined **mass** of the 3 weights in **grams**?
- 60.** What is the mass **in grams** of object X?

Station G: Animal Study

For Questions 61-70 use the background, procedure and data for the Investigation of “Learning” in Ants.

- 61.** What type of ant learning was tested in this experiment?
- 62.** What is the **dependent variable**? How is it measured?
- 63.** What is the **independent variable**? How is it measured?
- 64.** How many ants were used for each maze and how many trips were run for each ant?
- 65.** Where did the ant enter for maze A? Where did the ant enter for maze B?
- 66.** What was considered an error for the ants?
- 67.** What did maze A allow the ants to do? (Give the route) ie. food-maze-nest or maze-food-nest
- 68.** What did maze B allow the ants to do? (Give the route)
- 69.** What % of the errors made in Run 1 were made in Run 30 for Maze A? (round off to whole %)
What % of the errors made in Run 1 were made in Run 30 for Maze B? (round off to whole %)
- 70.** Which route (Maze A or Maze B) is easier for the ants to learn? Why?

Station H: Osmosis Study

For Questions 71 to 80, use the Background, Lab Setup and Osmosis Graph for the experiment described.

71. What is the **independent variable** and how is it measured?
72. What is the **dependent variable** and how is it measured?
73. What function does the dialysis bag serve for this experiment?
74. Which type of molecules are moving through the dialysis bag?
What type of molecules are too large to move through the dialysis bag?
75. The pressure reading indicates a change of pressure at what location?
What will cause the pressure to change?
76. What was the initial pressure reading for the three dialysis bags?
How much did the pressure change for the 50% solution?
77. How much did the pressure change for the 90% solution?
How much did the pressure change for the 100% solution?
78. How long did it take for the pressure change to begin to occur?
What 10 minute period had the greatest overall pressure increase for the three solutions?
79. Which dialysis bag expanded the most?
If this represented an animal cell what might happen to the cell membrane if it expands too much?
80. In a plant cell, where is the pressure exerted as the cell take on water?
What is this pressure called?

Station I: Ecology Analysis

For Questions 81-85, use the **Forest Food Web** and the **Energy Pyramid**.

81. Who are the producers for this Food Web? What **percent** of the Energy do the Producers have available?
82. Primary (1st order) consumers eat the producers. List the **primary consumers** on this food web?
83. Which **organisms** on this food web eat the grasshoppers?
84. Which organisms are the **highest (3rd order)** consumers for this food web?
85. The producers have **6000 kilograms** per square meter per year. How many kilograms per square meter per year would be available for the **1rd order or primary consumers**? How many kilograms per square meter per year should be available for the **3rd order consumers**?

For Questions 86- 90, use the **clear plastic sample box with seeds**, the **metric ruler**, the **Sample Diagram** and the **Food Chain**.

(**Note:** each seed in the clear plastic box represents an organism and **1 sq. meter = 1 sq. kilometer**)

86. What is the length & width of the clear plastic sample box floor (white region) in **centimeters to the nearest cm**? Convert the dimensions to **meters to the nearest 0.01m**.
87. What is the area of the clear plastic box sample floor in **square meters to the nearest 0.01m**?
88. Examine the plastic sample box and the sample diagram. How many **specimens** are in the plastic **sample box**? Which **symbol** on the **Sample Diagram** (**O**, **<**, **X** or **O**) represents the specimens in the plastic sample box?
89. Which **organism** on the Food Chain is represented by the specimens in the clear plastic sample box? Is this organism a **producer** or is it a **consumer**?
90. Based on the organisms in the clear plastic box, how many **organisms per square kilometer** should be present in that area? (See the **Note** above)

Station J: Observe, Infer & Key

Observations are things you can actually notice using your senses.
Inferences are logical conclusions based upon observations.

For questions 91-92, use the key and information available for Fingerprints **A-H**.
Indicate whether each is an observation (**O**) or an inference (**I**) using one of the following:

I:I, I:O, O:I, or O:O

- 91.** Basic fingerprint patterns are arch, loop and whorl. There are 2 types of arches and 2 types of loops.
- 92.** There are 4 types of whorls. Whorls are most common because there are more types.

For Questions 96-100, use the Fingerprints (**A-H**) and the **Dichotomous Key of Fingerprints** to answer the following questions. **Fingerprint patterns are from the right hand of the individuals.**

93. What is specimen **A**?

94. What is specimen **B**?

95. What is specimen **C** ?

96. What is specimen **D** ?

97. What is specimen **E** ?

98. What is specimen **F** ?

99. What is specimen **G** ?

100. What is specimen **H** ?

BIO-PROCESS LAB - DIVISION B
KEY

Bio-Process Lab 2016 National

TEAM NUMBER _____

STATE _____

SCHOOL _____

STUDENT NAMES: (PLEASE PRINT)

1. _____
2. _____

RAW SCORE _____

RANK _____

POINTS _____

BE SURE TO INCLUDE APPROPRIATE UNITS WITH ALL ANSWERS!!!

STATION A: Microscopy

1. 40X 100X 400X
2. D D D (all decrease)
3. toward 11 o'clock
4. _____
5. 40X 400X
6. 1/4 1/16
7. 1600 mcm
8. 200 mcm
9. .4mm 400 mcm
10. 15 cells

STATION D: Data Interpretation

31. 6-11 servings
32. 2 2-3 servings
33. fruits & veggies 5-9 servings
34. 425 g 236 g
35. 2 servings 390 calories
36. 9% 22%
37. 9% 16%
38. 10% 37%
39. none iron (10)
40. 72% water

STATION B: Diagram Analysis

11. B Trisomy 15
12. A Monosomy 10
13. P R
14. Q S
15. Grandmother & Grandson
16. D C
17. I F
18. I D
19. B H
20. F G

STATION E: Equipment & Safety

41. fumes fire(heat)
42. radiation poison
43. A C G H
44. B D E F
45. A E
46. I 60 cc syringe
47. A stethoscope & sygmomanometer
48. L O
49. K N P
50. C G J

STATION C: Plant Study

21. photosynthesis chloroplast
22. chlorophyll absorbs light
23. carbon dioxide & water
24. adds carbon dioxide
25. distance cm
26. bubbles number of
27. elodea, water, bicarbonate (amount of)
28. oxygen glucose
29. 17% 6%
30. closer = more photosynthesis

Note:

Black = order on key

Red = any order

Go to Station F-turn over answer sheet

BIO-PROCESS LAB - DIVISION B
KEY

STATION F: Measurement

51. 10 mm 1 mm
 52. 11.4 mm 114 mm
 53. 20 mL 2 mL
 54. 10 mL 1 mL
 55. 52.9 mL (53 mL)
 56. - 3.5 degrees Celcius
 57. 0.00 grams
 58. 102.31 grams
 59. 737.5 grams
 60. 891.1 grams

STATION I: Ecology Analysis

81. grass 100%
 82. mice rabbits lizards
 83. lizards & hawks
 84. hawk
 85. 600 g 6 g
 86. 18cm x 13cm 0.18m X 0.13m
 87. 0.2 sq.m
 88. 14 specimens X
 89. mice consumers
 90. 700 mice/sq.kilometer

STATION G: Animal Study

61. How ants learn to navigate
 62. Errors number of
 63. Trip number
 64. one 30 trips
 65. nest food
 66. wrong route-turned around
 67. maze-food-nest
 68. food-maze-nest
 69. 6% 1%
 70. B Route-straight to food

STATION J: Observe, Infer, Key

91. O:O
 92. O:I
 93. Plain Whorl
 94. Central Pocket Whorl
 95. Plain Arch
 96. Ulna Loop
 97. Tented Arch
 98. Double Loop Whorl
 99. Radial Loop
 100. Accidental Whorl

STATION H: Osmosis Study

71. Time minutes
 72. Pressure kPa (kilopascal)
 73. semipermeable membrane
 74. water sugar
 75. in dialysis bag-water moved out
 76. 102 kPa 3 kPa
 77. 10 kPa 12 kPa
 78. 8 min 20-30 min
 79. 100% it would burst
 80. against cell wall-Turgor pressure

Note:**Black = order on Key****Red = any order***Go to Station A-turn over answer sheet*

Team Number	Number of Teams →	1. Rocket Name or Team Name	Fight 1		Fight 2		Final Ranking	
			Time	Score	Time	Score	Rank	Team Name
1	Muscatel Middle School (CA)	CA Y Y N	16.44 (16.41)	16.50	Y Y N	15.75 (15.58)	15.62	1 Solon Middle School (OH)
2	Winston Churchill Middle School (CA)	CA Y Y N	15.25 (15.21)	15.19	Y Y N	16.63 (16.31)	16.50	2 Daniel Wright Junior High School (IL)
3	Pleasant Hill Middle School (NC)	NC Y Y N	16.22 (16.12)	16.32	Y Y N	13.23 (13.10)	13.28	3 Muscatel Middle School (CA)
4	Fried J. Carnegie Middle School (NC)	NC Y Y N	3.73 (3.81)	3.82	Y Y N	10.84 (10.63)	10.72	4 Marie Murphy (IL)
5	Meads Mill Middle School (MI)	MI Y Y N	15.98 (16.03)	15.94	Y Y N	15.04 (15.09)	15.02	5 Winston Churchill Middle School (CA)
6	Lakeshore Middle School (MI)	MI Y Y N	12.38 (12.07)	12.15	Y Y N	15.50 (15.50)	15.44	6 Russel Independent Middle School (KY)
7	Paul J. Gehring Junior High School (NY)	NY Y Y N	13.94 (13.81)	13.72	Y Y N	13.34 (13.35)	13.38	7 Meads Mill Middle School (MI)
8	Eagle Hill (NY)	NY Y Y N	3.77 (3.87)	3.15	Y Y N	10.53 (10.28)	10.63	8 Latke Middle School (MD)
9	Daniel Wright Junior High School (IL)	IL Y Y N	16.46 (16.52)	16.50	Y Y N	16.32 (16.28)	16.09	9 Hamilton Middle School (IL)
10	Marie Murphy (IL)	IL Y Y N	16.65 (16.76)	16.61	Y Y N	15.01 (15.12)	15.70	10 Auburn Junior High School (AL)
11	Springhouse Middle School (PA)	PA Y Y N	11.66 (11.72)	11.72	Y Y N	10.34 (10.43)	10.38	11 Lakeshore Middle School (MI)
12	Bale Cyndy Middle School (PA)	PA Y Y N	11.06 (10.87)	11.00	Y Y N	11.53 (11.25)	11.73	12 Community Middle School (NJ)
13	Solon Middle School (OH)	OH Y Y N	16.97 (17.06)	17.00	Y Y N	12.01 (12.25)	25.37	13 Paul J. Gehring Junior High School (NY)
14	Maggie Middle School (OH)	OH Y Y N	10.91 (10.97)	11.47	Y Y N	14.21 (14.10)	14.07	14 Longview Middle School (VA)
15	Cogden Middle School (GA)	GA Y Y N	10.23 (10.16)	10.31	Y Y N	8.91 (8.76)	8.53	15 Beckendorff Junior High (TX)
16	Fulton Science Academy (GA)	GA Y Y N	3.17 (3.46)	3.17	Y Y N	14.22 (14.28)	14.27	16 Pembroke Hill Middle School (MD)
17	Ladue Middle School (MO)	MO Y Y N	16.09 (16.13)	16.03	Y Y N	13.85 (13.98)	13.79	17 Maggie Middle School (OH)
18	Pembroke Hill Middle School (MO)	MO Y Y N	12.38 (12.44)	12.07	Y Y N	13.01 (13.08)	13.07	18 Webnok Middle School (ME)
19	Beckendorff Junior High (TX)	TX Y Y N	11.26 (12.09)	12.18	Y Y N	13.89 (13.93)	13.69	19 Austin Area Homeschoolers (TX)
20	Austin Area Homeschoolers (TX)	TX Y Y N	12.53 (12.67)	12.65	Y Y N	11.53 (11.75)	11.73	20 Storer Middle School (OR)
21	Archimedes Model Conservatory (FL)	FL Y Y N	9.99 (9.75)	9.95	Y Y N	11.12 (11.03)	11.09	21 Yanaton Middle School (SD)
22	Gatesy Middle School (FL)	FL Y Y N	9.79 (9.94)	10.05	Y Y N	12.43 (12.40)	12.35	22 Farfield Junior High (UT)
23	Northshore Junior High (WA)	WA Y Y N	10.88 (10.75)	10.94	Y Y N	11.15 (11.12)	10.94	23 Aborigine Area Home Schoolers (NV)
24	Frontier Middle School (WA)	WA Y Y N	10.22 (10.46)	10.38	Y Y N	9.46 (9.54)	9.25	24 Bale Cyndy Middle School (PA)
25	Thomas Jefferson M.S. (IN)	IN Y Y N	9.34 (9.85)	9.61	Y Y N	9.37 (9.47)	9.34	25 St. John Berchmans (LA)
26	Bearden Middle School (TN)	TN Y Y N	9.47 (9.41)	3.31	3.45	10.44 (10.45)	4.44	26 Springhouse Middle School (PA)
27	Preston Middle School (CO)	CO Y Y N	9.01 (8.81)	8.81	8.99	11.93 (11.97)	8.19	27 Northshore Junior High (GA)
28	California Trail Middle School (KS)	KS Y Y N	9.97 (10.00)	10.15	Y Y N	11.74 (11.76)	7.97	28 Wachter Middle School (ND)
29	Wachter Middle School (ND)	ND Y Y N	12.01 (11.87)	11.75	Y Y N	10.25 (10.00)	9.93	29 Paragon Science Academy (AZ)
30	Longview Middle School (VA)	VA Y Y N	9.79 (12.06)	12.09	Y Y N	12.44 (12.01)	12.55	30 North Bethesda Middle School (MD)
31	Hamilton Middle School (WI)	WI Y Y N	13.69 (13.26)	13.69	Y Y N	15.01 (15.12)	15.16	31 Archimedes Model Conservatory (FL)
32	Auburn Junior High School (AL)	AL Y Y N	14.04 (13.62)	13.69	Y Y N	15.15 (14.07)	14.79	32 Eagle Hill (NY)
33	Community Middle School (NH)	NH Y Y N	14.03 (13.91)	13.92	Y Y N	13.88 (13.82)	13.21	33 Barrington Middle School (RI)
34	Mission Middle School (NE)	NE Y Y N	8.37 (8.86)	8.87	8.87	10.48 (10.75)	10.65	34 Galaxy Middle School (FL)
35	Albuquerque Area Home Schoolers (NM)	NM Y Y N	11.37 (11.13)	11.13	Y Y N	11.56 (11.47)	11.44	35 Frontier Middle School (WA)
36	North Bethesda Middle School (MD)	MD Y Y N	10.92 (10.80)	10.15	Y Y N	11.10 (11.34)	11.79	36 Fulton Science Academy (GA)
37	Reedburn Middle School (DE)	DE Y Y N	9.22 (9.28)	9.42	Y Y N	10.25 (10.00)	10.25	37 Pied J. Carnegie Middle School (NC)
38	A. W. Coddige Middle School (MA)	MA Y Y N	8.29 (8.09)	9.19	Y Y N	8.81 (8.75)	8.93	38 HB Allport Middle School (DE)
39	Convalis Middle School (MT)	MT Y Y N	4.53 (4.59)	4.47	Y Y N	11.81 (11.81)	4.47	39 Thomas Jefferson M.S. (IN)
40	Russell Independent Middle School (KY)	KY Y Y N	15.25 (15.30)	15.50	Y Y N	16.05 (16.05)	16.21	40 Casey School (OK)
41	Paragon Science Academy (AZ)	AZ Y Y N	11.25 (11.31)	11.41	Y Y N	10.18 (10.28)	10.34	41 Dogen Middle School (GA)
42	Farfield Junior High (UT)	UT Y Y N	10.35 (10.46)	10.50	Y Y N	12.89 (12.70)	12.00	42 Presse Middle School (CO)
43	Chippewa Middle School (MN)	MN Y Y N	8.15 (8.10)	8.01	8.01	8.84 (8.81)	8.81	43 California Trail Middle School (KS)
44	Highlands Intermediate School (HI)	HI Y Y N	9.23 (9.29)	9.29	Y Y N	10.84 (10.72)	10.65	44 A. W. Coddige Middle School (MA)
45	St. Joseph's Catholic (IL)	IL Y Y N	11.97 (11.86)	11.79	Y Y N	10.21 (10.31)	10.15	45 Tedand Middle School (AK)
46	Cataldo School (OK)	OK Y Y N	12.09 (12.09)	12.47	Y Y N	8.82 (8.28)	8.54	46 Lynde - Off Lyne Middle School (CT)
47	Clinton Middle School (SC)	SC Y Y N	5.09 (5.19)	5.05	Y Y N	8.15 (8.10)	5.20	47 Germantown Middle School (MS)
48	Barrington Middle School (RI)	RI Y Y N	9.21 (9.28)	9.25	Y Y N	10.89 (10.84)	10.75	48 Chippewa Middle School (MN)
49	Germantown Middle School (MS)	MS Y Y N	8.15 (8.22)	8.15	Y Y N	1.71 (1.73)	1.73	49 Ames Middle School (IA)
50	Tealand Middle School (AK)	AK Y Y N	4.73 (4.72)	4.46	Y Y N	12.13 (12.08)	12.09	50 Huntington Middle School (WV)
51	Stover Middle School (OH)	OH Y Y N	11.27 (12.25)	12.72	Y Y N	10.81 (10.81)	11.09	51 Piedmont B Middle School (NC)
52	Lynde - Off Lyne Middle School (CT)	CT Y Y N	8.60 (8.64)	8.61	8.61	8.01 (8.12)	8.54	52 St. Joseph's Catholic (IL)
53	USA Academy (AR)	AR Y Y N	5.29 (5.34)	5.33	Y Y N	11.79 (11.83)	5.19	53 Highlands Intermediate School (HI)
54	St. John Berchmans (LA)	LA Y Y N	11.01 (11.01)	10.90	Y Y N	11.01 (11.18)	11.59	54 Hyde Park MS Academy of So and Math (NY)
55	Annes Middle School (IA)	IA Y Y N	3.12 (3.10)	3.44	Y Y N	5.81 (5.07)	5.22	55 Ciron Middle School (SC)
56	Hyde Park MS Academy of So and Math (NY)	NY Y Y N	3.25 (3.37)	3.19	3.19	16.12 (16.38)	16.15	56 USA Academy (AR)
57	Woodlawn Middle School (ME)	ME Y Y N	11.20 (11.69)	11.93	Y Y N	12.65 (12.72)	12.69	57 Convalis Middle School (MT)
58	Yankee Middle School (SC)	SC Y Y N	12.92 (12.76)	12.07	Y Y N	10.31 (10.44)	10.44	58 Weston Middle School (NE)
59	Riverton Middle School (WY)	WY Y Y N	6.25 (5.16)	6.31	6.31	5.19 (5.18)	5.16	59 Bearden Middle School (TN)
60	Huntington Middle School (WV)	WV Y Y N	3.15 (3.25)	3.16	3.16	4.91 (5.12)	4.97	60 Riverton Middle School (WY)
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Check-In Order	Team Number	Team Name	State	Bridge Mass (00.01 g)	Bridge Width (00.1 cm)	Load Scored (1. g)	Tier	Score
4	C09	Adlai E. Stevenson	IL	3.89	4.0	15,000	1	3,856.041
16	C19	Liberal	TX	4.52	9.2	15,000	1	3,318.584
23	C32	Auburn	AL	4.21	5.0	11,625	1	2,761.283
5	C10	New Trier	IL	5.32	3.1	14,335	1	2,694.549
9	C03	Troy	CA	5.13	4.5	13,560	1	2,643.275
61	C17	Boca Raton	FL	4.75	5.0	12,305	1	2,590.526
38	C04	Mira Loma	CA	5.88	4.1	15,000	1	2,551.020
17	C20	Seven Lakes	TX	5.59	4.9	14,095	1	2,521.467
47	C16	Chattahoochee	GA	6.41	4.4	15,000	1	2,340.094
6	C31	Langley	VA	6.27	5.5	13,030	1	2,078.150
8	C08	Troy	MI	4.41	4.7	8,905	1	2,019.274
40	C07	Northville	MI	5.05	4.0	10,145	1	2,008.911
56	C26	Bismarck	ND	7.73	4.6	14,860	1	1,922.380
32	C11	Harriton	PA	5.24	5.2	9,610	1	1,833.969
21	C28	Mounds View	MN	4.96	5.0	9,055	1	1,825.605
53	C29	Lincoln Southwest	NE	6.47	4.0	11,660	1	1,802.164
45	C14	Centerville	OH	5.45	4.6	9,795	1	1,797.248
14	C13	Solon	OH	5.27	2.6	9,155	1	1,737.192
13	C24	Menomonie	WI	5.62	4.8	9,455	1	1,682.384
39	C30	West Windsor-Plainsboro	NJ	5.77	5.5	9,475	1	1,642.114
37	C34	Russell	KY	7.64	4.0	12,000	1	1,570.681
34	C27	Bothell	WA	8.48	4.0	13,300	1	1,568.396
59	C37	Acton-Boxborough	MA	6.19	5.3	8,860	1	1,431.341
31	C22	Pembroke Hill	MO	8.08	4.4	11,515	1	1,425.124
10	C06	Raleigh	NC	7.37	4.2	10,265	1	1,392.809
49	C39	Centennial	MD	8.92	4.5	12,235	1	1,371.637
51	C05	Enloe Magnet	NC	5.89	5.7	8,050	1	1,366.723
35	C52	Clark	NV	5.54	4.0	7,470	1	1,348.375
29	C18	Archimedean	FL	6.08	5.1	7,575	1	1,245.888
57	C33	Olathe North	KS	8.68	5.0	10,740	1	1,237.327
55	C49	Barrington	RI	6.15	5.5	7,575	1	1,231.707
20	C53	Capital	ID	9.95	5.4	12,150	1	1,221.106
58	C23	Carmel	IN	11.77	5.4	14,010	1	1,190.314
19	C12	Bayard Rustin	PA	6.64	3.9	7,735	1	1,164.910
44	C21	Ladue Horton Watkins	MO	6.58	5.1	7,530	1	1,144.377
52	C15	Brookwood	GA	7.83	5.5	8,925	1	1,139.847
42	C02	Ward Melville	NY	13.31	5.4	15,000	1	1,126.972
18	C36	Wilmington	DE	5.01	4.0	5,315	1	1,060.878
27	C42	Iolani	HI	6.23	3.8	5,400	1	866.774
36	C01	Columbia	NY	6.60	4.5	5,610	1	850.000
2	C41	Hamilton	MT	18.43	5.0	15,000	1	813.890
28	C35	Fossil Ridge	CO	5.78	4.5	4,655	1	805.363
33	C47	Clinton	SC	13.49	3.5	10,005	1	741.660
1	C43	Maple Mountain	UT	5.72	5.2	4,155	1	726.399
60	C59	Yankton	SD	4.73	5.3	3,090	1	653.277
15	C57	Casady	OK	9.08	4.0	5,390	1	593.612
3	C25	Farragut	TN	13.34	5.2	7,915	1	593.328
30	C54	St. Mary's	OR	7.14	7.2	4,230	1	592.437
54	C38	Albuquerque	NM	13.41	4.8	7,865	1	586.503
43	C51	Waterville	ME	12.71	4.2	7,055	1	555.075
7	C56	Mat-Su	AK	4.16	5.5	2,010	1	483.173
48	C46	Bedford	NH	16.80	4.9	7,610	1	452.976
25	C40	South Windsor	CT	6.55	2.5	2,700	1	412.214
50	C48	Baton Rouge	LA	10.69	7.7	3,785	1	354.069
26	C45	Oxford	MS	43.54	6.3	15,000	1	344.511
24	C50	Ames	IA	14.57	3.9	4,015	1	275.566
12	C44	Catalina Foothills	AZ	12.02	3.0	1,855	1	154.326
11	C60	Huntington	WV	41.88	5.5	4,190	1	100.048
46	C58	Campbell	WY	6.48	5.2	120	1	18.519
22	C55	Little Rock	AR	23.26	7.8	2,665	3	114.574
41	C61	Kaiyo Academy	JA	36.44		6,690	AUDIT	183.589

Crave The Wave

Test Booklet

National Science Olympiad Competition 2016, Division B (Middle School)

Team School _____, Team Name _____

Name of Students _____, _____

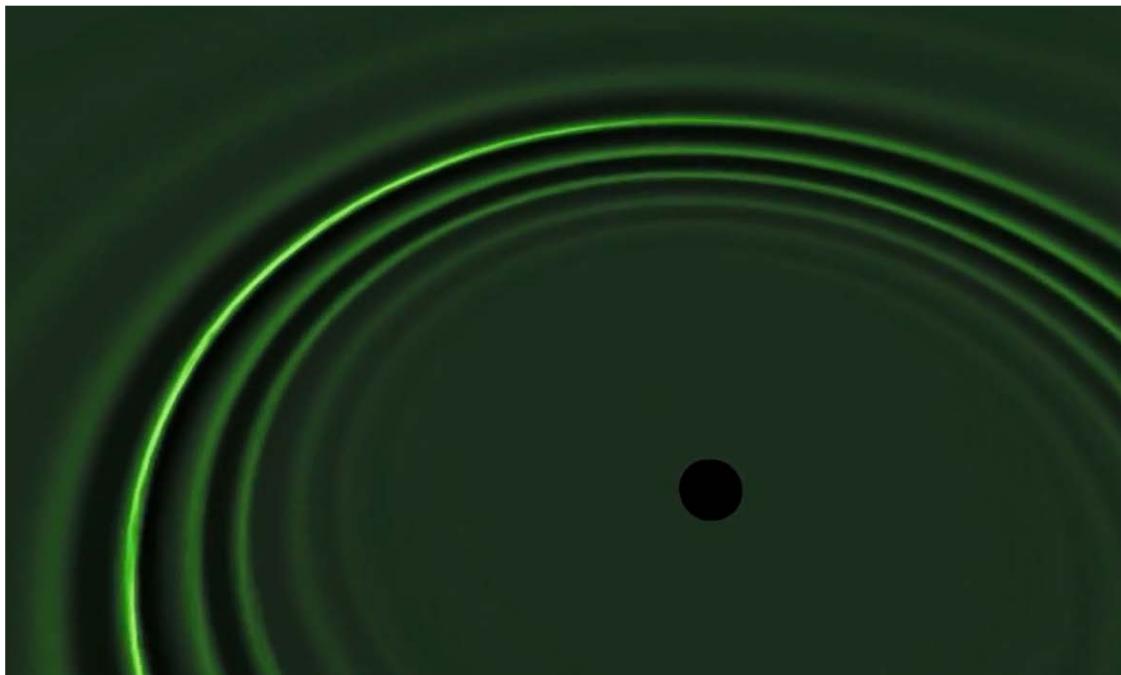
State _____

Do Not Open This Test Booklet Until Instructed To Do So.

You are permitted reference materials, writing utensils, protractors, rulers, and any type of calculators (calculators that don't connect to the internet). All reference materials must be secured in a 3-ring binder and won't fall out. All reference material that falls out will be placed aside and not allowed to be used.

Answer each question to the best of your ability. Place the answer in the blank provided and include units when appropriate. Show all your work in the space provided below the question or on the graph. The points for each answer is shown. There are 10 stations. There are 100 total possible points. You will be given 4 minutes and 30 seconds for each station. Move up for each station change. Such that, go from station #1 to #2 and, if you are at station #10, go to station #1.

Tie-breaker will be based upon highest score on station #9. If still tied, then highest score on station #8. If still tied, then highest on station #7, and so on.



Simulated gravity waves produced by colliding Black Holes.

Crave The Wave

National Science Olympiad Competition 2016, Division B (Middle School)

Test Booklet

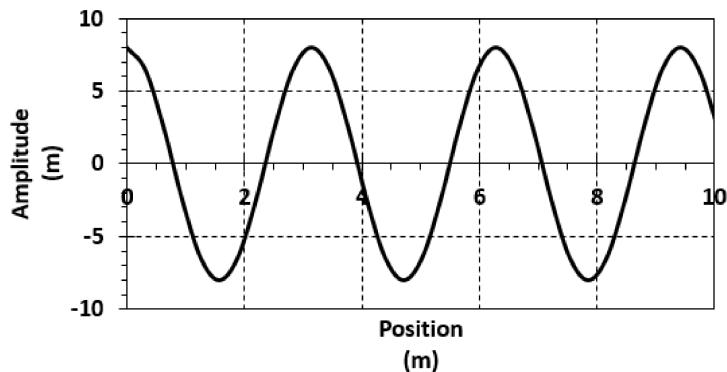
Crave The Wave

Test Booklet

National Science Olympiad Competition 2016, Division B (Middle School)

Station 1

Questions 1-4 refer to the diagram below. This diagram represents a transverse wave moving along a rope with a frequency of 0.72 hertz.



1. The wavelength for this wave is _____. (2 points)
2. The amplitude for this wave is _____. (3 points)
3. The velocity of the wave is _____. (3 points)
4. It takes _____ of time for a small piece of the rope at position 2 meters to transversely displace from zero to 6 meters. (3 points)

Crave The Wave

Test Booklet

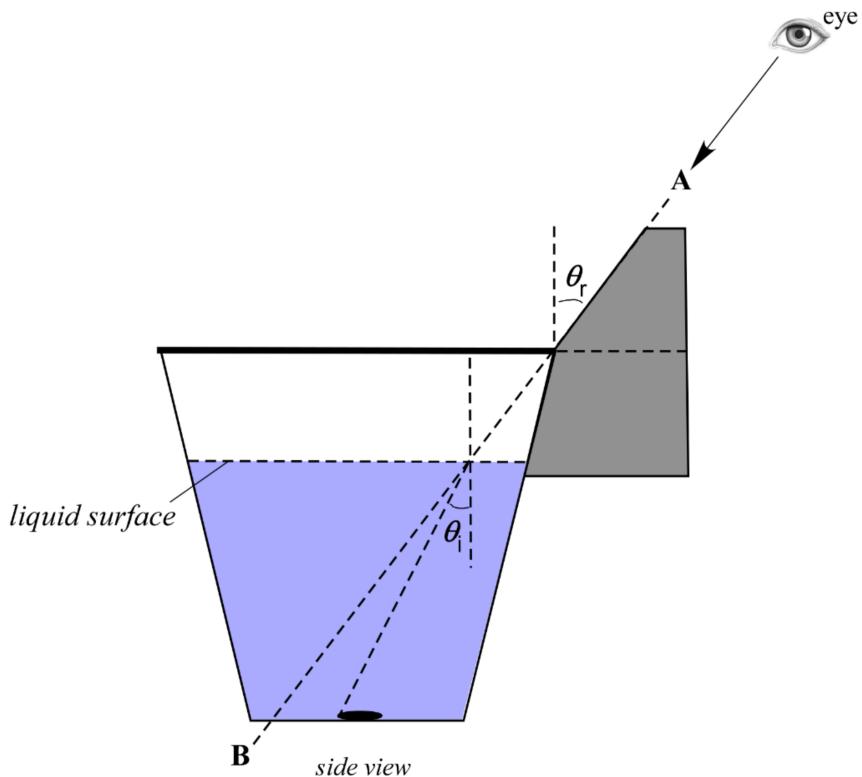
National Science Olympiad Competition 2016, Division B (Middle School)

Station 2

Set out before you at this station are two cups. The red cup should be mostly filled with an unknown, yet safe, liquid. The other cup has transparent sides and a plastic vane on its side. A side view of this cup is shown below. This cup also has a black circle on its bottom. With one eye open, sight along line **A-B** as shown below. Keeping the vane perpendicular to the rim, begin filling the transparent cup with the liquid until you just begin seeing a portion of the black circle to the left of A-B in the diagram. (Do not over-fill this cup.)

5. The angle of refraction, θ_r , is _____. (1 point)
6. The height of the water in the cup is _____. (2 points)
7. The angle of incidence, θ_i , is _____. (2 points)
8. The value of $\sin \theta_i$ is _____. (2 points)
9. The value of $\sin \theta_r$ is _____. (2 points)
10. Using Snell's Law, the index of refraction of the unknown liquid is _____.
(2 points)

Pour the liquid back into the red cup before moving to a different station.



Crave The Wave

Test Booklet

National Science Olympiad Competition 2016, Division B (Middle School)

Station 3

Questions 11-16 pertain to the piece of metal at this station.

11. The velocity of a longitudinal wave in solid metal depends on _____ and _____.

(4 points)

12. The mass of the rod is _____.

(1 point)

13. The length of the rod is _____.

(1 point)

14. The diameter of the rod is _____.

(1 point)

15. The density of the rod is _____.

(2 points)

16. Young's Modulus is a physical property of metal that describes how stiff the material is for stretching and compressing. If Young's Modulus for this metal is 105 GPa, the velocity of longitudinal waves in this metal is _____.

(3 points)

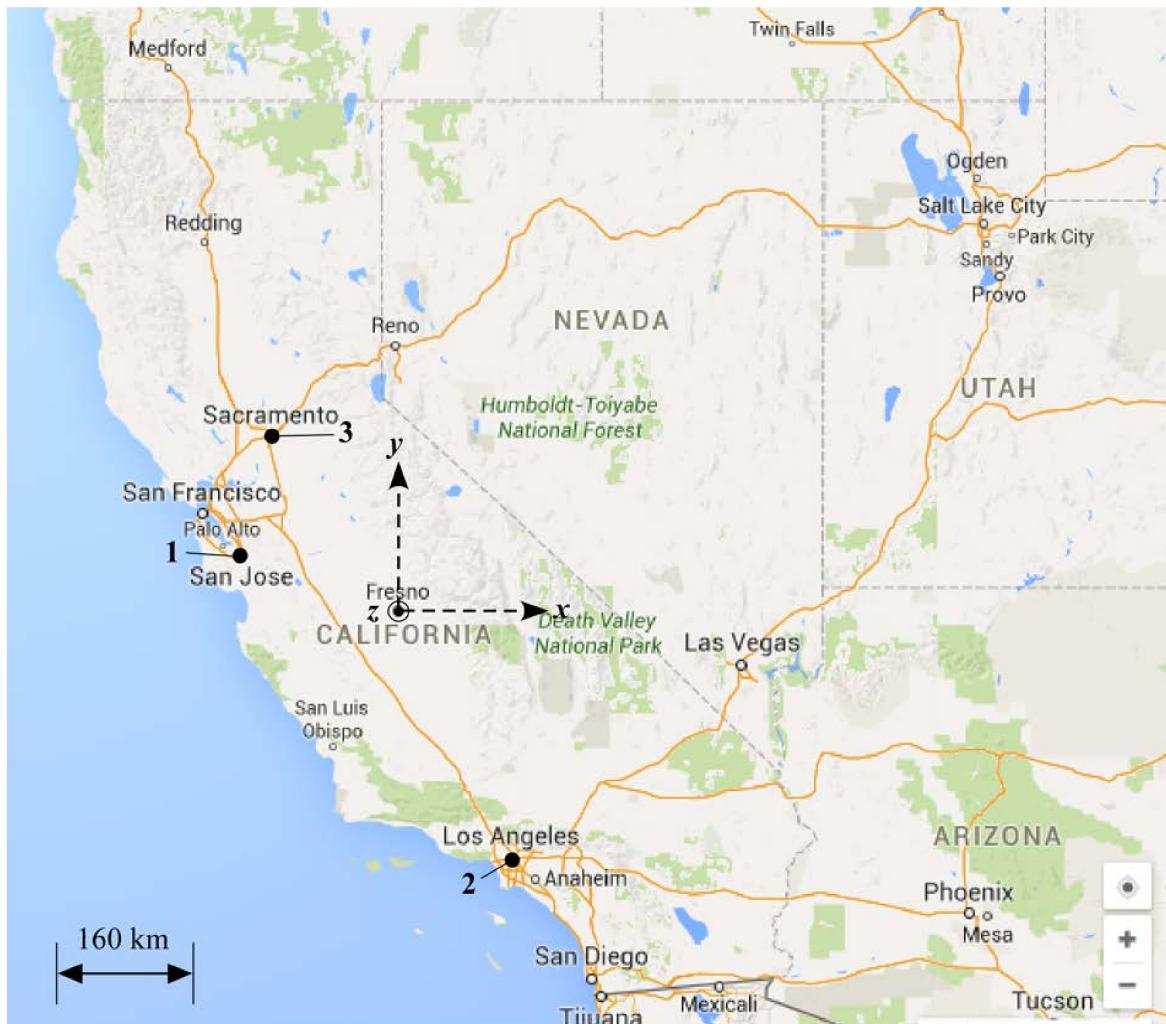
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National Science Olympiad Competition 2016, Division B (Middle School)

Station 4

Suppose there are three seismograph stations at the given locations and identified with numbers **1**, **2**, and **3**. Let Fresno, CA, be the location on the map that the origin is assigned with the rectangular coordinate system of the positive **x**-direction being toward the right, positive **y**-direction is up, and the positive **z**-direction is out-of-the-page toward you. Assume the velocity of the P-wave is 7.00 km/s and the velocity of the S-wave is 4.00 km/s. Also assume that all locations are in the same time zone.



The speed in which these waves travel through the earth equals distance divided by time.

17. The surface location just above the focus of an earthquake is called the _____. (2 points)

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Test Booklet

National Science Olympiad Competition 2016, Division B (Middle School)

18. Suppose the ground snaps at exactly 1:00pm with a focus located at Los Angeles and is close to the surface. The P-waves from this earthquake will arrive at Sacramento (location 3) at the exact time (down to the nearest second) of _____ . (3 points)

19. Given the same earthquake as described in question #17 above, the S-waves from this earthquake will arrive at Sacramento (location 3) at the exact time (down to the nearest second) of _____ . (3 points)

Now, a different earthquake strikes somewhere in California. The exact time of the earthquake is unknown and the depth of its focus is also unknown. What is known is the time between the arrival of the P-waves and S-waves at each seismograph station.

The time between the P and S-waves arriving at location 1 (San Francisco) is 33.3 seconds.

The time between the P and S-waves arriving at location 2 (Los Angeles) is 47.0 seconds.

The time between the P and S-waves arriving at location 3 (Sacramento) is 39.3 seconds.

20. The focus of this new earthquake is a distance of _____ away from location 1 (San Francisco). (2 points)

21. The surface location just above the focus is located at the coordinates of $x = -84.5$ km and $y = -25.4$ km. This earthquake had a depth of _____ . (4 points)

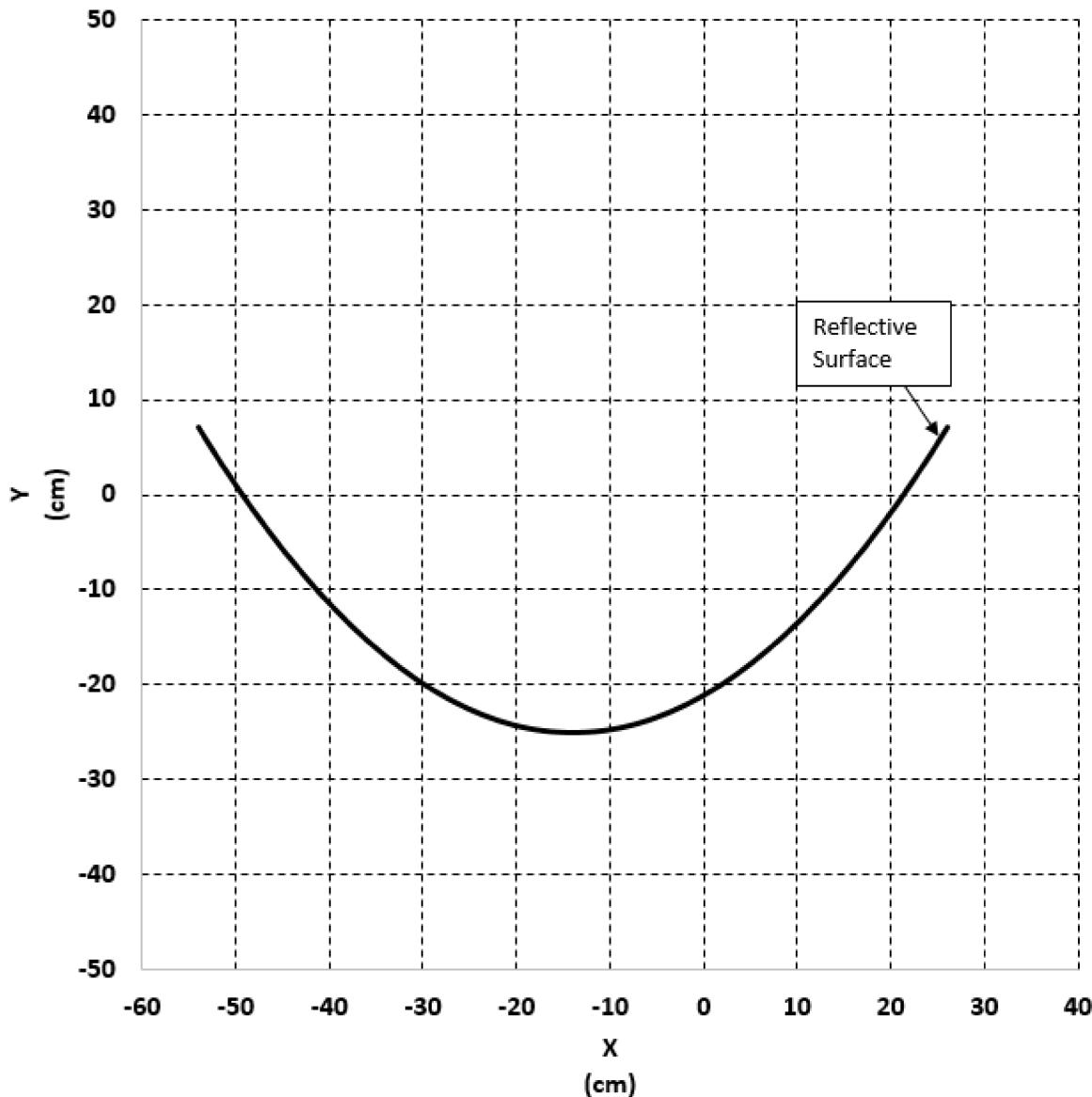
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National Science Olympiad Competition 2016, Division B (Middle School)

Station 5

Questions 22-24 involve the parabolic reflector which is shown below. The inside surface is reflective.



22. A light wave approaches the reflector along the negative Y-direction having an X-value of -30 cm. Draw the direction in which this light wave reflects off the surface. (2 points)

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Test Booklet

National Science Olympiad Competition 2016, Division B (Middle School)

23. A light wave approaches the reflector along the negative Y-direction having an X-value of 0 cm. Draw the direction in which this light wave reflects off the surface. (2 points)

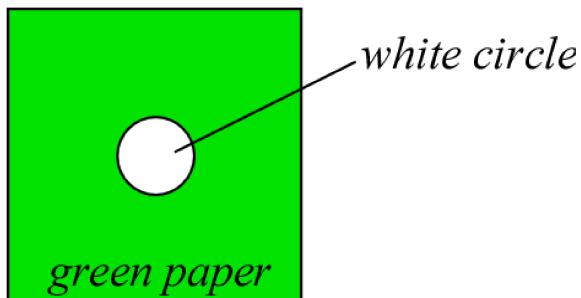
24. The X and Y-coordinate for the focus of this reflector are _____ and _____, respectively. (4 points)

Station 6

Consider the situation in which only a green laser light illuminates the entire square card which is green-colored with a white-colored circle as shown below.

25. What an observer sees with their eyes would correspond to letter _____ below. (2 points)

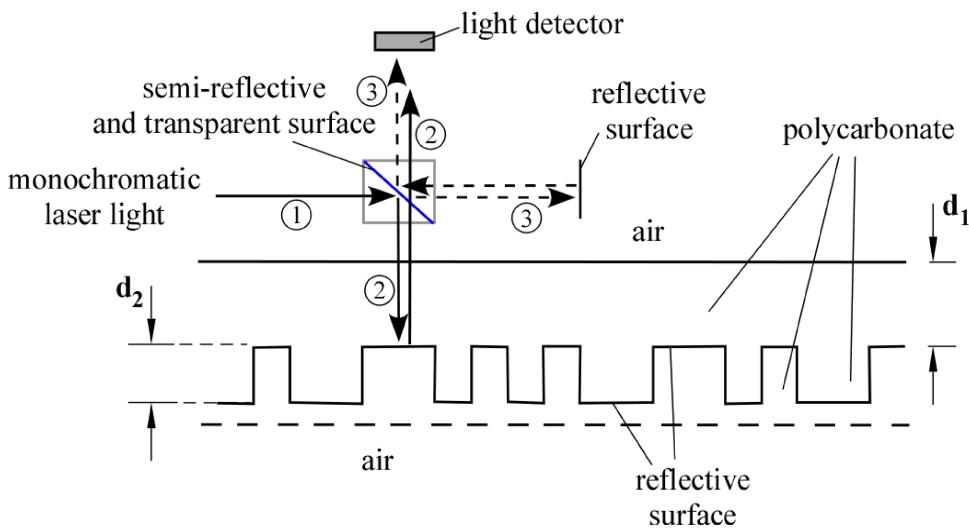
- A) A green square with a black circle in the middle.
- B) A black square with a green circle in the middle.
- C) A black square with no circle in the middle.
- D) A green square with a white circle in the middle.
- E) A green square with no circle in the middle.



26. Explain your reasoning (4 points):

Station 7

The diagram below shows a simplified version of how optical drives work for storing information. Use this diagram to answer questions 27-31. Let the in-coming laser light (shown as path number 1) have a wavelength of 405 nm in air. This beam is split into two parts. One part following path 2 and the other following path 3. Paths 2 and 3 enter the light detector superimposed upon one another. Let this polycarbonate material have an index of refraction of 1.62. Paths 2 and 3 constructively interfere when path 2 reflects off the peaks, of the peaks and valleys, of the reflective surface. Paths 2 and 3 destructively interfere when path 2 reflects off the valleys, of the peaks and valleys, of the reflective surface.



27. The speed of this laser light in air is _____. (2 points)
28. The speed of this laser light in polycarbonate is _____. (2 points)
29. For light from path 2 to destructively interfere with light from path 3 at the light detector, their path length difference must be $\frac{n}{2} \lambda$ where λ is the wavelength and n equals _____. (2 points)
30. The wavelength of this light in the polycarbonate is _____. (2 points)
31. If $d_1 + d_2 = 1.2\text{mm}$, the minimum distance that d_2 can be is _____. (3 points)

Station 8

Potassium-40 ($^{40}_{19}K$) is a naturally occurring radioactive isotope of potassium with a half-life of 1.25 billion years. About 11% of the time it decays into Argon-40 ($^{40}_{18}Ar$) where the difference in mass ultimately gets converted into two photons of equal energy. The mass of Potassium-40 is 6.6340×10^{-26} kg and the mass of Argon-40 is 6.6338×10^{-26} kg. Use this decay sequence to answer questions 32-34.

32. The difference in the mass between Potassium-40 and Argon-40 is _____. (2 points)

33. One of the most famous equations in all of science is Albert Einstein's energy-mass equivalence which is algebraically expressed as $E = mc^2$. The energy of each photon involved in the decay of Potassium-40 to Argon-40 is _____. (3 points)

34. The frequency of each photon is _____. (2 points)

35. The photons belong to the _____ region of the electromagnetic spectrum. (2 points)

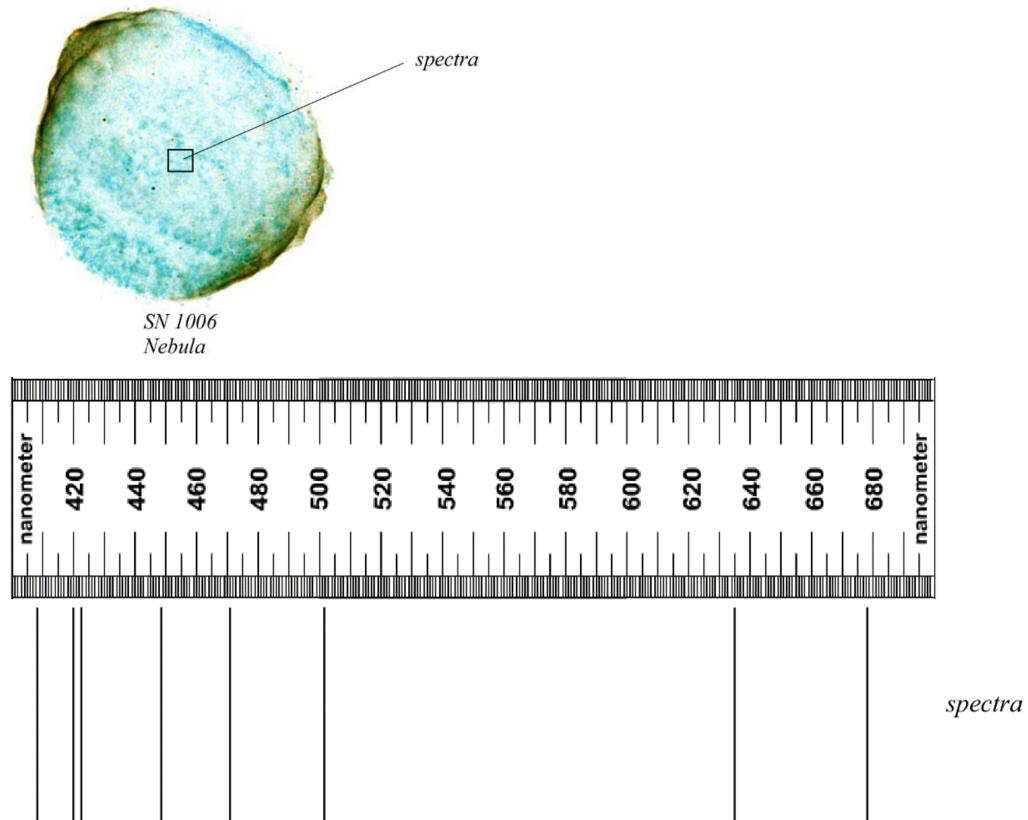
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National Science Olympiad Competition 2016, Division B (Middle School)

Station 9

A careful analysis of the light coming from the center of SN 1006 nebula (which is a supernova remnant) creates two superimposed, Doppler shifted, hydrogen emission spectra as shown in the spectra below. This comes from the expanding spherical shell of gas. Assume the center of the expanding sphere is not moving with respect to the Earth.



36. The longest wavelength spectral line has been shifted by _____ nanometers. (2 points)

37. The ratio of the shifted wavelength (for the longest wavelength) divided by the non-shifted wavelength is _____. (2 points)

38. The velocity of the expanding shell of gas is _____ with respect to the center of the sphere. (4 points)

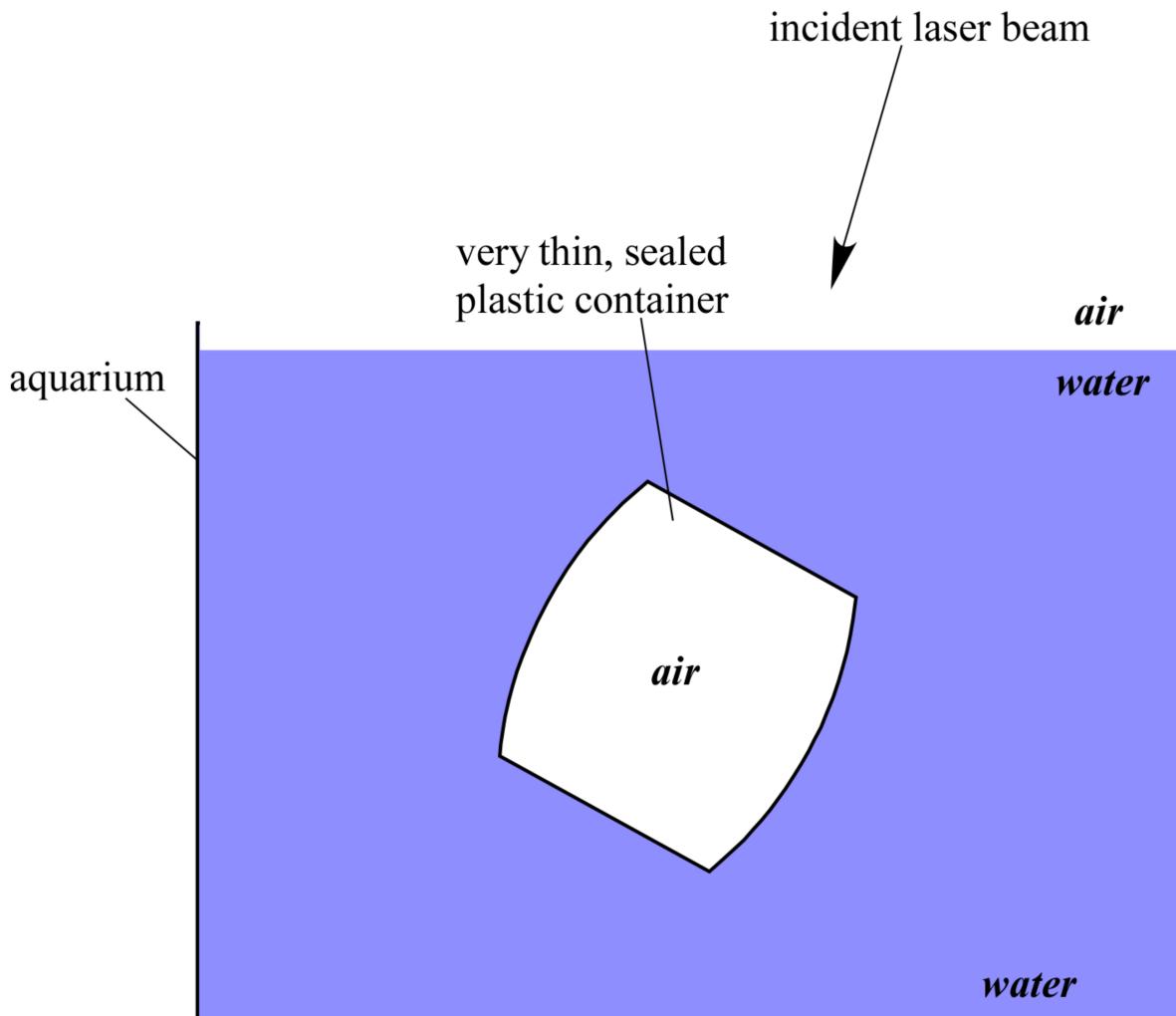
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Test Booklet

National Science Olympiad Competition 2016, Division B (Middle School)

Station 10

A laser beam is incident on an aquarium filled with water as shown below.



39. The index of refraction of water is _____. (2 points)

40. The index of refraction of air is _____. (2 points)

41. Sketch the path this laser beam takes as it enters the water, passes through the container, exists the container and passes near a letter. (6 points)

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Key
Test Booklet

National Science Olympiad Competition 2016, Division B (Middle School)

Team School _____, Team Name _____

Name of Students _____, _____

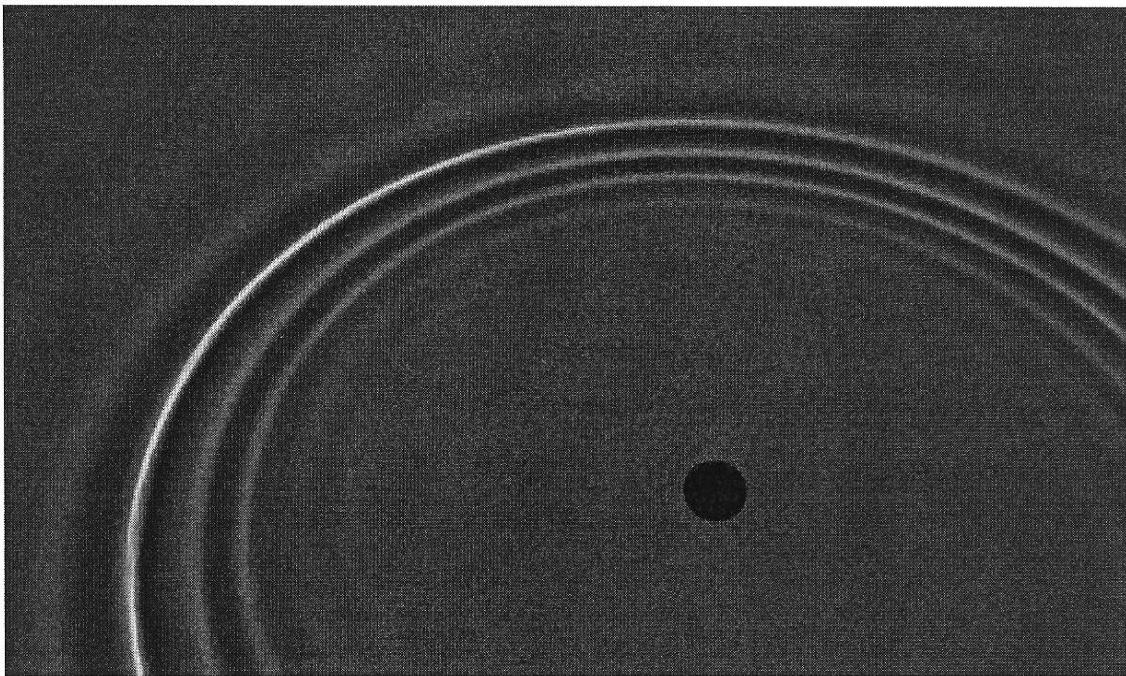
State _____

Do Not Open This Test Booklet Until Instructed To Do So.

You are permitted reference materials, writing utensils, protractors, rulers, and any type of calculators (calculators that don't connect to the internet). All reference materials must be secured in a 3-ring binder and won't fall out. All reference material that falls out will be placed aside and not allowed to be used.

Answer each question to the best of your ability. Place the answer in the blank provided and include units when appropriate. Show all your work in the space provided below the question or on the graph. The points for each answer is shown. There are 10 stations. There are 100 total possible points. You will be given 4 minutes and 30 seconds for each station. Move up for each station change. Such that, go from station #1 to #2 and, if you are at station #10, go to station #1.

Tie-breaker will be based upon highest score on station #9. If still tied, then highest score on station #8. If still tied, then highest on station #7, and so on.



Simulated gravity waves produced by colliding Black Holes.

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National Science Olympiad Competition 2016, Division B (Middle School)

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(Spare page.)